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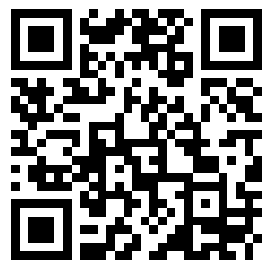

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REPUBLIC OF NIGERIA

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NUTRITION SURVEY

FEBRUARY-APRIL 1965

A REPORT BY THE NUTRITION SECTION
OFFICE OF INTERNATIONAL RESEARCH
NATIONAL INSTITUTES OF HEALTH

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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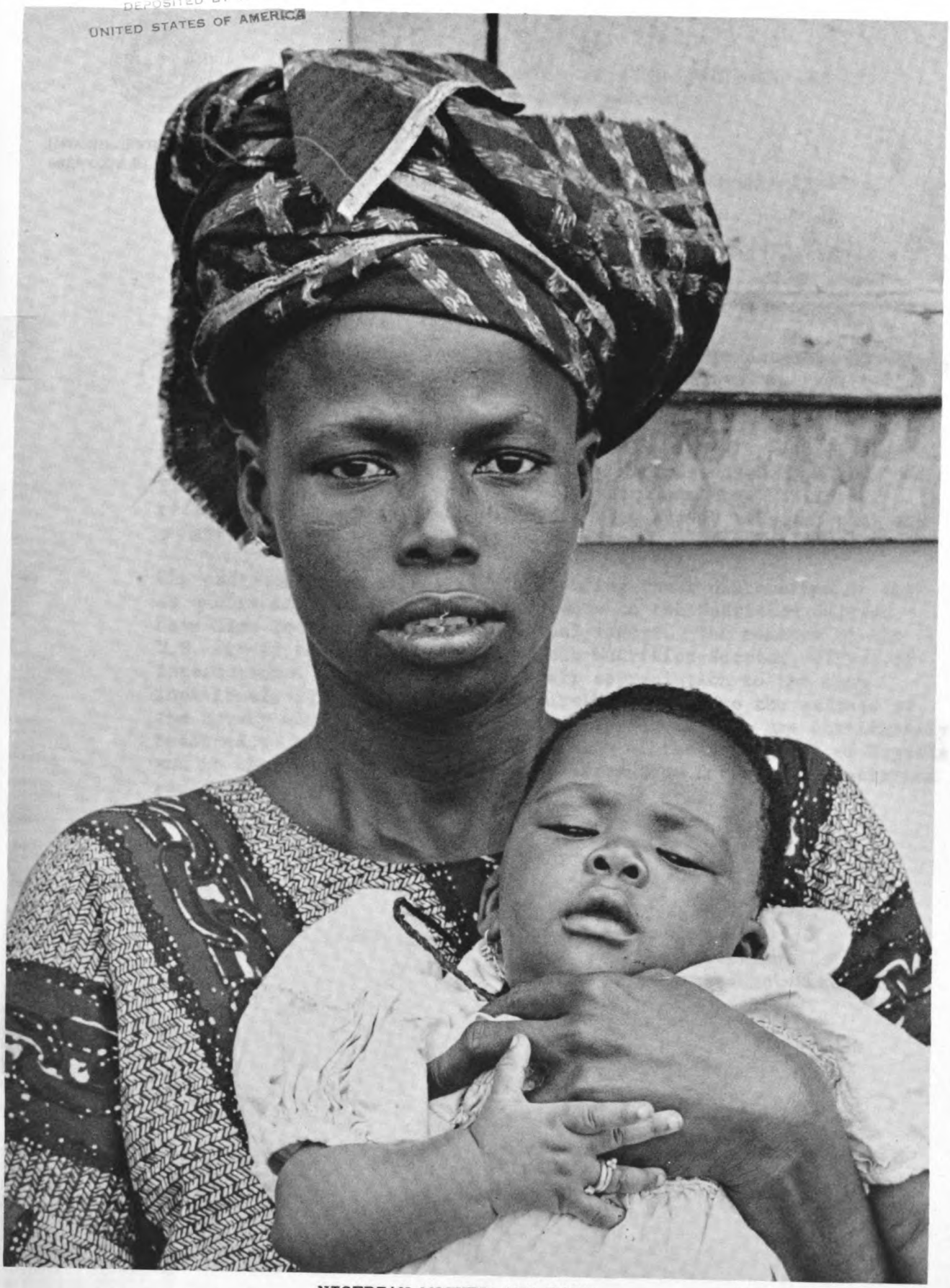

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March 6, 1967

On behalf of the Nutrition Section, Office of International Research, National Institutes of Health, it is my pleasure to transmit the Report of the Nutrition Survey of Nigeria which was conducted by the joint Nigerian--United States team, February through April 1965.

This report has been prepared following discussions held during the first week of June 1966 among Nigerian team members, interested officials of the Nigerian government, U.S. survey team members, and a representative of the Nutrition Section.

The excellent suggestions received during these discussions as well as additional comments made by advisors to the Nutrition Section have been incorporated into the final report. The members of the U.S. survey team and the staff of the Nutrition Section, Office of International Research, express their appreciation to the many individuals in Nigeria who have contributed both to the success of the survey and to the preparation of the report. We are particularly indebted to the collaborating Ministries of the Government of Nigeria and to the Nigerian members of the survey team for their cooperation and support.

Arnold E. Schaefer
Head, Nutrition Section
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FOREWORD

Much attention has been given over many years to the subject of nutrition in Nigeria. Most of the recent studies, however, are localized in scope and deal with but a limited aspect of the broad questions. The 1965 survey of nutritional health, production, and use of food is an effort to identify the considerations involved in nutritional planning for the country, including the opportunities and need for further research and areas of needed educational development. This report presents in detail the findings of the survey and elucidates means believed to be within the resources of the Government of Nigeria and others concerned for an effective attack on the problems encountered.

Although the problems are numerous, the rapidly developing institutions of higher learning, the forward-looking research and development activities within the Government of Nigeria, and the significant investments of international organizations, of major foundations, and of bilateral assistance programs are providing both climate and facilities in which the growing number of competent personnel can enhance the development of this progressive country.

It is hoped, therefore, that this report may serve as an additional stimulus to coordinated developments by the Government of Nigeria, University and Research Institutions, and other agencies and may improve meaningfully and continuously the nutritional health of the people of the country.

Arnold E. Schaefer

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NIGERIA

Nutrition Survey

(February through April 1965)

A Report of the Nutrition Section, Office of International Research,
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Bethesda, Maryland
Dept. of HEW
1967

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TABLE OF CONTENTS

		Page
	Acknowledgments	VII
	Nutrition Survey Team	XII
	List of Tables	XIII
	List of Figures	XVIII
	Summary and Recommendations	XX
I.	Introduction	1
II.	Background	2
III.	General Design of the Survey	20
IV.	Agriculture, Food Production, and Food Availability	23
V.	Survey of Nigerian Food Samples for Aflatoxins	39
VI.	Food Consumption Studies	50
	Civilians	52
	Military	60
	School Feeding Study	81
VII.	Biochemical Results	90
	Civilians	90
	Military	99
VIII.	Parasitologic Studies	112
IX.	Clinical Findings	123
	Pediatric Group	123
	Adults and Children Over 5 Years	144
	Pregnant and Lactating Women	166
	Military and Police	168
X.	Dental Health	175
XI.	Intellectual Correlations of Nutritional and Other Characteristics of Nigerian Children	199
XII.	Special Studies	
	Study of Vitamin A Deficiency in Young Children	213
	Appendixes	222

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LIST OF TABLES

Table		Page
	Background	
1	Food Balance, Nigeria 1959-61 (Estimated Population 39,400,000)	12
2	Nutrient Composition of the Average Daily Diets Eaten by Rural Nigerian Peasant Farmers in Seven Different Areas of the Country	14
	Agriculture, Food Production, And Food Availability	
3	Nigerian Exports, 1963 and 1965	23
4	Estimated Livestock Population in Thousands, Nigeria, 1963	25
5	Average Annual Production of Food Crops, Nigeria	26
6	Meat Production, Nigeria	26
7	Food Imports, Nigeria	27
8	Food Exports, Nigeria	27
9	Estimated Available Foodstuffs (1,000 Long Tons)	28
10	Estimated Nutrients Available Per Capita Per Day From Available Food Supply	28
	Survey Of Nigerian Food Samples For Aflatoxins	
11	Results of Analyses for Aflatoxins, Nigeria	44
	Food Consumption Studies	
12	Composition of Civilian Sample in Three-Day Dietary Studies by Location, Nigeria	51
13	Food Prices and Amounts Sold in Some Nigerian Markets, 1965	54
14	Composition of the Civilian Sample in the Seven-Day Diet Study, Nigeria	58
15	Summary of Calorie and Protein Values of Epe, Hunkuyi (Zaria) and Port Harcourt Diets, February/March, 1965	59
16	Comparison of Regulation Daily Ration Issue with Actual Ration Issue, A.P. Versus E.P. Weight, Nigeria Military School, 1965	63
17	Daily Ration Issue, Total Amounts and Per Man Amounts, Nigeria Military School, Northern Nigeria, 1965	64
18	Calculated Nutrient Intake Per Cadet Per Day From the Daily Ration Issue, Nigeria Military School, Zaria	75
19	Menus for the Three Day Survey Period, Company A Mess, Zaria, Northern Nigeria	78
20	Food Consumption and Waste Study, Company A Mess, Zaria, Northern Nigeria	82
21	Food Ration Per Student, Per Day as Devised by the Nutrition Council for the Federal School Feeding Program, Nigeria	83
22	Calculated Nutrient Intakes from Federal School Feeding Program, Lagos, Nigeria, March 1965	84
23	Average Nutrient Intake in Nigerian Civilian Families by Location as Determined by Chemical Analysis	86
24	Summary of Average Nutrient Intake in Nigerian Catering Messes by Chemical Analysis	87
25	Nutrient Intake Per Person Per Day (Recipe Method), Civilian--Nigeria, 1965	88
26	Nutrient Intake Per Person Per Day (Recipe Method), Military--Nigeria, 1965	89

Digitized by Google

LIST OF TABLES (Continued)

Table		Page
	Biochemical Results	
27	Age Distribution of Non-Pregnant Non-Lactating and Pregnant or Lactating Females in the Biochemical Sample, Nigeria	91
28	Age Distribution Males (Civilian,Military, Police) in the Biochemical Sample, Nigeria	91
29	Interpretive Guide to Biochemical Data for Children (0-5 Years), Nigeria	92
30	Interpretive Guide to Biochemical Data for Males and Females, 15+years, Nigeria	93
31	Interpretive Guide to Biochemical Data for Pregnant or Lactating Females, Nigeria	94
32	Total Plasma Protein Levels, Civilian Population, Nigeria	94
33	Plasma Albumin Levels, Civilian Population, Nigeria	95
34	Plasma Globulin Levels, Civilian Population, Nigeria	95
35	A/G Ratio, Civilian Population, Nigeria	95
36	Urinary Thiamine Excretion, Civilian Population, Nigeria	97
37	Urinary Riboflavin Excretion, Civilian Population, Nigeria	97
38	Urinary N'-Methylnicotinamide Excretion, Civilian Population, Nigeria	97
39	Plasma Vitamin A Levels, Civilian Population, Nigeria	98
40	Plasma Carotene Levels, Civilian Population, Nigeria	98
41	Plasma Vitamin C Levels, Civilian Population, Nigeria	98
42	Hemoglobin Levels, Civilian Population, Nigeria	98
43	Hematocrit Values, Civilian Population, Nigeria	100
44	Mean Corpuscular Hemoglobin Concentration, Civilian Population, Nigeria	100
45	Urinary Iodine Excretion, Civilian Population, Nigeria	101
46	Plasma Cholesterol Levels, Civilian Population, Nigeria	101
47	Total Plasma Protein Levels, Military and Police, Nigeria	102
48	Plasma Albumin Levels, Military and Police, Nigeria	102
49	Plasma Globulin Levels, Military and Police, Nigeria	103
50	A/G Ratio, Military and Police, Nigeria	103
51	Urinary Thiamine Excretion, Military and Police, Nigeria	104
52	Urinary Riboflavin Excretion, Military and Police, Nigeria	104
53	N'-Methylnicotinamide, Military and Police, Nigeria	106
54	Plasma Vitamin A Levels, Military and Police, Nigeria	107
55	Plasma Carotene Levels, Military and Police, Nigeria	107
56	Plasma Vitamin C Levels, Military and Police, Nigeria	108
57	Hemoglobin Levels, Military and Police, Nigeria	108
58	Hematocrit, Military and Police, Nigeria	109
59	Mean Corpuscular Hemoglobin Concentration, Military and Police, Nigeria	109
60	Urinary Iodine Excretion, Military and Police, Nigeria	110
61	Plasma Cholesterol Levels, Military and Police, Nigeria	110

Digitized by Google

Table		Page
	Parasitologic Studies	
62	Numbers of Individuals by Sex, Age, and Region Receiving Parasitologic Examinations, Nigeria	113
63	Prevalence of Intestinal Parasites in 380 Nigerians Based on Single Stool Examination by M I F and M I F C Technics	114
64	Prevalence of the Principal Intestinal Parasites Found in 287 Nigerian Civilians, Tabulated by Region	114
65	Prevalence of Combinations of Parasites by Region, Nigeria	115
66	Presence of Blood Parasites by Region, Nigeria	116
67	Presence of Blood Parasites by Sex and Age, Nigeria	117
68	Mean Numbers of Eosinophils by Sex and Age in Nigerians in Parasitologic Study	119
69	Mean Numbers of Eosinophils by Region in Nigerians in Parasitologic Study	119
70	Eosinophil Counts for Individuals Having Certain Parasitic Infestations, Nigeria	120
71	Hemoglobin Levels in Individuals with Hookworm or Ascaris, Nigeria	120
	Clinical Findings	
	Table Addenda 1. Sample and Region, Pediatric Clinical Study	125
72	Clinical Findings by Location, Pediatric Sample, Nigeria	127
73	Clinical Findings by Age and by Sex, Pediatric Sample, Nigeria	130
74	Clinical Findings by Region, Pediatric Sample, Nigeria	133
	Table Addenda 2. Infant Mortality by Regions	136
75	Biochemical Levels of Nutrients by Age in Children 0-4 Years, Nigeria	141
76	Age and Sex Distribution by Region, Clinical Sample, Nigeria	145
77	Mean Age, Height, Weight and Percent "Standard Weight" by Sex and Location, Individuals 15 Years and Above, Nigeria	149
78	Clinical Findings by Sex and Age, Abbreviated Examinations, Nigeria	150
79	Clinical Findings by Location, Abbreviated Examinations, Nigeria	151
80	Percent Prevalence of Thyroid Enlargement by Sex and Age in Plateau and Rain Forest Regions	157
81	Selected Clinical Findings by Sex and Age, Detailed Examinations, Nigeria	162
82	Selected Clinical Findings by Location, Detailed Examinations, Nigeria	163
83	Clinical Findings Among Pregnant or Lactating Women, Detailed Examination, Nigeria	167
84	Mean Height, Weight and Percent of "Standard Weight" by Location of Military Personnel and Police Cadets	169
85	Clinical Findings by Location Among Military Personnel and Police Cadets, Abbreviated Examination, Nigeria	170
86	Selected Clinical Findings by Location Among Military Personnel and Police Cadets, Detailed Examinations, Nigeria	171

Digitized by Google

Table		Page
	Dental Health	
87	Number of Persons Receiving Dental Examinations in Nigeria, 1965	176
88	Mean Number of df Teeth Per Person by Age and Location for all Persons Examined in Nigeria, 1965	177
89	Mean df Per Person, A Comparison of the High Economic Class Schools with the Rural Areas, Nigeria, 1965	181
90	Fluoride Content of Water Samples Collected in Nigeria, 1965	184
91	Observed Prevalence of Enamel Fluorosis	184
92	Mean PI, DI-S, CI-S, and OHI Per Person by Age Group for all Groups Examined in Nigeria, 1965	186
93	Percentage of Persons with Destructive Periodontal Disease by Age Group, Military and Civilian, Nigeria, 1965	189
94	Mean PI, DI-S, CI-S, and OHI by Age for Children in the High Economic Class Schools in Lagos and Ibadan, 1965	191
95	Mean PI, DI-S, CI-S and OHI by Age for Children in the Poor Area Schools (All Regions), Nigeria, 1965	191
96	Mean Periodontal Disease Scores for the Nigerian Groups Compared with Published Figures for Other Population Groups	195
	Intellectual-Correlations Of Nutritional and Other Characteristics Of Nigerian Children	
97	Means, Standard Deviation, Ranges and Tests of Significance for the Ibadan (Elite "E") and Osegere Village (Village "V") Groups	202
98	Means, Standard Deviation, Ranges and Tests of Significance for the Experimental (E) and Control (C) Groups in the Epe (Vitamin Deficiency) Study	209
	Special Studies	
99	Observations on 1,108 Children Under 5 Years of Age Examined on Six Consecutive Days in General Practice Clinic	214
100	Observations on Children Examined in Special Clinics at University College and Adeoyo Hospitals, Ibadan	215
101	Cases of Kwashiorkor Admitted to Adeoyo Hospital October 1962-January 1965	216
102	Carotenoids in Normal Adult Serum Samples	216
103	Carotenoid and Vitamin A Levels in Blood Samples from Malnourished Children	217
104	Levels of Carotenoids and Vitamin A in Breast Milk of Nursing Mothers	218
	Appendixes	
1	Some Plants Gathered for Food in Nigeria	223
2	Additional Plants Gathered for Food (Nigeria)	226
3	Methods Used to Determine Presence of Aflatoxins in Foods	228
4	Suggested Guide to Interpretation of Nutrient Intake Data	230
5	Minerals in Water Samples, Nigeria	231
6	Biochemical Findings by Sex and Age, Nigeria	232
7	Biochemical Findings by Sex, Age, and Region, Nigeria	236
8	Biochemical Findings by Sex, Age, and Region, Nigeria	240
9	Biochemical Findings by Sex, Age, and Region, Nigeria	244

Digitized by Google

LIST OF TABLES (Continued)

Table		Page
	Appendixes (Continued)	
10	Biochemical Findings by Sex, Age, and Region, Nigeria	248
11	Biochemical Findings by Age, Military and Police, Nigeria	252
12	Biochemical Findings by Region, Military and Police, Nigeria	256
13	Biochemical Findings for Pregnant or Lactating Females by Region, Nigeria	260
14	Biochemical Levels of Nutrients by Region in Children 0-4 Years, Nigeria	264
15	Intelligence Testing Materials	267
16	Recommended Daily Allowance of the Most Important Nutrients	286

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LIST OF FIGURES

Figure		Page
	Background	
1	Map of Nigeria	3
2	Vegetation Zones of Nigeria Showing the Situation of the Villages in Which the Studies of Food Consumption Were Made	15
	Parasitologic Studies	
3	Nigerian Children Waiting for Clinical Examinations	122
	Clinical Findings	
4	Mean Weights and Heights of Nigerian Boys 0--4 Years of Age	138
5	Mean Weights and Heights of Nigerian Girls 0--4 Years of Age	139
6	Mean Weights and Heights of Nigerian Boys 5--17 Years of Age Compared with Those of North American Boys	146
7	Mean Weights and Heights of Nigerian Girls 5--17 Years of Age Compared with Those of North American Girls	147
8	Comparison of Average Weight by Age of Adults of Same Height in Nigeria and North America	153
9	Skinfold Measurements by Age and Sex, Nigeria	154
10	Skinfold Measurements by Sex and Percent "Standard Weight," Adults, 15+ Years, Nigeria	155
11	Thyroid Enlargement by Age and Sex, Nigeria	158
12	Mean Systolic and Diastolic Blood Pressure Levels by Sex and Age, Nigeria	160
13	Mean Systolic and Diastolic Blood Pressure by Sex and Percent of "Standard Weight," Adults, 15+ Years, Nigeria	161
	Dental Health	
14	Performance of a Dental Examination	174
15	Mean Number of DF Teeth Per Person by Age Group, Nigeria	179
16	Mean Number of Decayed and Filled Teeth Per Person by Age and Geographical Location, Compared with Findings for the High Economic Class Nigerian Children (Males and Females Combined)	180
17	Comparison of Mean DF Per Person in the High Economic Group Schools with Figures for Children in the Rural Areas	183
18	Mean Periodontal Disease Scores by Age for Persons Examined in Nigeria, 1965 (Males and Females Combined)	187

Digitized by Google

LIST OF FIGURES (continued)

Figure		Page
19	Percentage of Persons with Destructive Periodontal Disease by Age Group and Regions, Nigeria	188
20	Noma Oris	192
	Appendix 17	
21	Growth of Nigerian Girls, Derived Savannah Region	288
22	Growth of Nigerian Girls, Savannah Region	289
23	Growth of Nigerian Girls, Plateau Region	290
24	Growth of Nigerian Girls, Urban Federal District	291
25	Growth of Nigerian Girls, Rain Forest Region	292
26	Growth of Nigerian Girls, Coastal Region	293
27	Growth of Nigerian Boys, Derived Savannah Region	294
28	Growth of Nigerian Boys, Savannah Region	295
29	Growth of Nigerian Boys, Plateau Region	296
30	Growth of Nigerian Boys, Urban Federal District	297
31	Growth of Nigerian Boys, Rain Forest Region	298
32	Growth of Nigerian Boys, Coastal Region	299

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SUMMARY AND RECOMMENDATIONS

1. An Advisory Council on Nutrition should be established at the Federal-Regional level, with membership from the ministerial or undersecretary level. A technical board to give technical professional guidance to this Council should be appointed, made up of persons from various regions of the country, but selected on the basis of individual competence.

2. There should be incorporated into the several community and sociologic studies which are under way at a number of places in the country, plans and procedures for gathering nutritional and related informational material. One central clearing house might be established under the guidance of the Advisory Council on Nutrition.

3. From biochemical, dietary, and clinical evidence, deficiency of riboflavin is severe and widespread. That thiamine intake also is marginal in certain groups is indicated by urinary thiamine excretion and dietary data. Food sources of riboflavin are limited. Efforts should be directed to increasing the intake of these two vitamins. The following measures will help to accomplish this end:

a. Through education, an effort should be made to encourage production and consumption of foods containing high levels of these vitamins, such as certain vegetables, meat, eggs, milk, and liver.

b. To provide thiamine and riboflavin, enrichment programs should be considered by the Federal Government when centralized production of food staples makes such programs feasible. At present only the flour milling industry is so centralized, but it provides a stable foodstuff for but a small segment of the population.

c. Education should be provided in methods of food preparation which will conserve the vitamins present in foodstuffs by reducing the use of excess cooking water and of protracted cooking. Consideration should be given to need for adequate storage conditions to preserve thiamine and riboflavin in foods.

4. The occurrence of clinically manifest protein-calorie malnutrition among infants and preschool children is noted, and numerous severe cases are commonplace in the hospitals visited. Associated examples of striking oral and ophthalmic lesions were noted, and the presence of anemia was observed. These evidences of malnutrition were in the age groups suffering from frequent respiratory, diarrheal, and infectious diseases, and often accompanied these diseases. An intensive program of education of physicians, midwives, and public health workers at all levels, as well as mothers, is needed to alleviate this burden.

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a. General education in basic understanding of nutritional and hygienic principles in relation to food and health should be incorporated in the schools, both primary and secondary, and in other educational programs such as extension services in agriculture, public health, and community service programs. Special emphasis should be given to principles of infant feeding and to the opportunity of teaching these to mothers in maternal and child health clinics, to midwives, and to nurses.

b. Such a program should include not only education as to infant care and feeding, but the development and production of suitable, cheap, nutritious food products for infant feeding -- products which can be prepared from food materials available in the home as well as those which are commercially feasible.

c. The apparent growth retardation of preschool and young school-aged children likewise indicates a need to emphasize the nutritional needs of this group in educational, community, and school feeding programs.

d. Biochemical findings on the pregnant or lactating mothers indicate that within this group many have deficits of important nutrients. The implication of these findings should be considered in planning both educational and health programs.

5. In view of the high prevalence and severity of periodontal disease found by the survey, there is need to give close attention to feasible preventive measures.

a. These measures should be initiated with individuals of all ages, beginning with young children, through demonstrations to the mothers at health clinics, in schools, dental clinics, and other suitable means.

b. Corrective and preventive measures should be instituted at once to improve the poor oral health seen in military personnel examined in the survey.

c. Attention should be directed especially to the prevention and early arrest of the facial lesion, cancrum oris, which is encountered fairly frequently in Nigeria.

d. In cognizance of the short supply of dental facilities, efforts should be initiated to increase them as rapidly as possible and to provide increased training opportunities for students in dentistry. These should include establishment of dental clinics in Government hosptals and provision of mobile dental clinics for use in rural areas. Training facilities for dental students should be expanded and, if feasible, should include establishment of another dental school. Public health aspects of dentistry should be emphasized in the curriculum.

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e. Information concerning prevention of oral health problems should be disseminated by public health workers, the local press, radio, and other effective methods.

6. Means to improve the available food supply should be sought, and information on better use of available food should be widely disseminated.

a. Probably the greatest short-term contribution to increasing food availability would be the prevention of wastage of products in storage and during transit. Increased effort in devising protective storage facilities for grains and legume seeds for both central and local storage is recommended. Judicial use of pesticides for central storage facilities should be further investigated. Special attention should also be given to proper drying and protection from moisture and thus from mold infestation. Demonstration of protective storage facilities at local and household levels is advocated.

b. Usefulness of home demonstration services in foods and nutrition will be enhanced if the educational efforts are based on good information. It is suggested that the village food consumption studies conducted by the Federal Office of Statistics can admirably provide the basis of planning the home demonstration efforts in foods and nutrition. It is strongly recommended that every effort be undertaken to make the results of these studies available for such planning purposes.

c. It is recommended that women trained for home-demonstration extension services receive training in the basic aspects of sanitation and child health. In some or all Regions this may entail Ministries of Health providing instruction to Ministry of Agriculture personnel.

7. Increases in food production should be stimulated and new foods introduced where this is practicable.

a. The problems of agronomic and livestock production are generally well understood, and it can only be recommended that research, demonstration, and educational efforts to solve them be continued and expanded as means permit.

b. Increasing the supply of beef presents a special problem aside from those of disease, availability of food and water, breed improvement, and the like. This stems from the fact that provision of beef has been, so to speak, a by-product of the Fulani traditional "beef-as-property" enterprise. The problem can be attacked either by superimposing upon the traditional attitude of the Fulani toward cattle an understanding of better and more efficient production and marketing of cattle, or by developing a cattle enterprise completely outside the Fulani tradition, or both. It is recommended both that attempts to educate the Fulani to adopt a commercial attitude as indicated above be continued, and that means of initiating other commercial cattle enterprises be devised.

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c. If it is ascertained that the indigenous goat in the southern regions is indeed resistant or immune to trypanosomiasis, research in its breeding and husbandry should be undertaken.

d. Research on use of available by-products as supplements to local feeds is recommended. Brewers grains and slops, milling offals, rice polishings, groundnut press cake, palm kernel press cake, and cottonseed are some of the materials that are or could be available for such use. Fish meal and slaughter house by-products will probably become available and they too should be studied.

8. Encouragement of the development of a food processing industry should be made by all sectors concerned.

a. A department of food science and technology should be established in one or more of the universities or training centers.

b. Close cooperation should be developed between the universities and the research institutes, both governmental and those supported by foundations, in the area of food science and technology. Arrangements for reciprocal use of staff and facilities for teaching, research, and product development should be established. Early projects might well include the development and commercial introduction of foods of traditional type (e.g. gari) but with enhanced nutritive value.

9. Although of the total number of foods sampled in this study relatively few were found to contain aflatoxins, the importance of the susceptible groundnut crop to the Nigerian economy and the potent hepatotoxicity of these products suggest that implementation of the following recommendations be given serious consideration:

a. Measures already in practice in some areas to eliminate contaminated groundnut kernels in the production of meal should be continued where they exist and expanded to other areas.

b. Improvements in methods of harvesting and storage of groundnuts to minimize contamination with molds should be instituted.

c. Since the foods sampled during this survey were all collected during the dry season, a year-round study of foods and foodstuffs should be made to determine any seasonal differences in levels of aflatoxins present, and to ascertain whether other foods may be dietary sources of aflatoxins, as well as the potential level of intake of aflatoxins by the population throughout the country.

10. In view of the progressive medical and research centers in Nigeria, it may be useful to note particularly a number of research

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opportunities which can be readily identified from these studies as of immediate importance to Nigeria.

a. Studies should be made of malnourished infants with cancrum oris aimed at determining whether there is a predisposing nutritional lack, identifying any nutrient factors involved, improving therapy, and prevention.

b. Research should be instituted to determine means to prevent periodontal diseases.

c. In view of some clinical suggestions that they occur, studies of folic acid deficiency states and of requirements for this vitamin should be made.

d. Advantage should be taken of the opportunity to develop major research programs on the relation of malnutrition to mental development and neuromuscular function.

e. Further investigation should be undertaken of the identity, distribution, and role of mycotoxins in problems of human and animal health.

f. In view of the high consumption of red palm oil throughout much of the country and of the high carotenoid levels found in the biochemical studies, investigations concerning the nature and metabolism of the dietary carotenoids are especially relevant and opportune.

g. The nutritional relationships of the neurologic syndrome described in the region of Epe should be further elucidated.

h. Systematic acquisition of data on nutrient composition of Nigerian foods should be continued and the results accumulated.

11. A system of food supply and distribution organized and operated by the Army is needed to assure delivery of adequate and high quality food to Nigerian troops.

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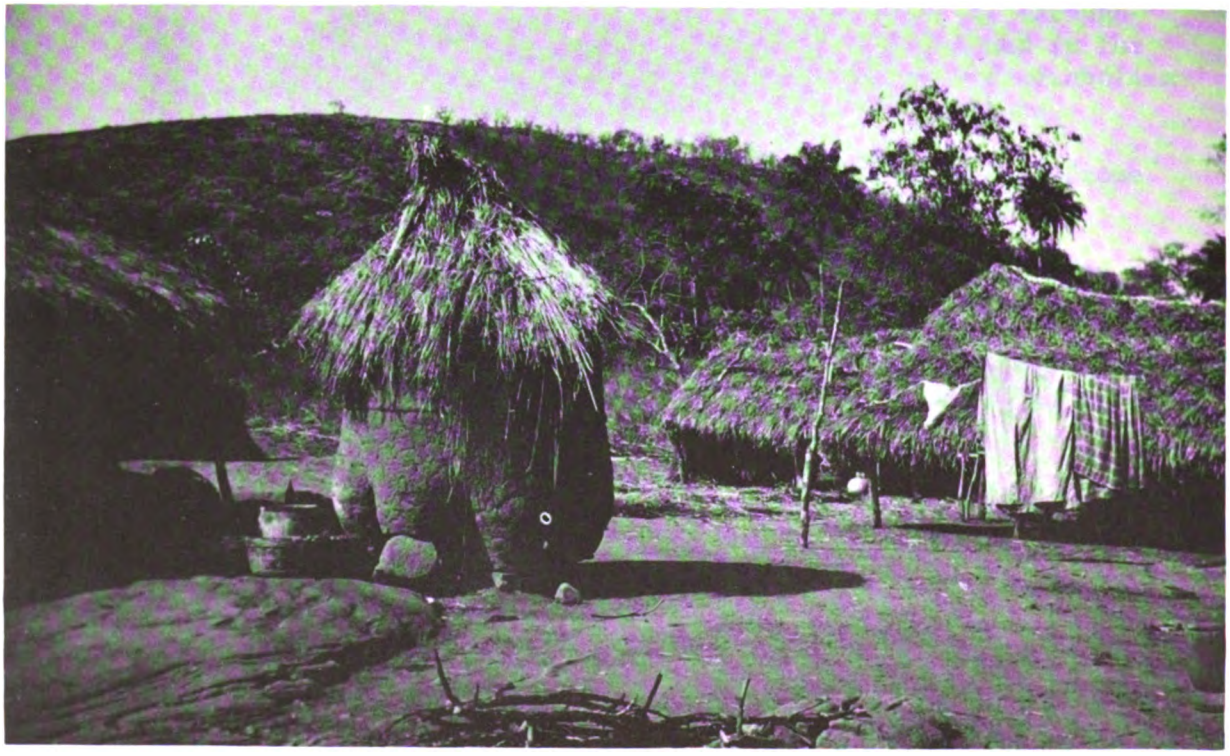

Top : Pyramid of Sacked Peanuts at Kano
Bottom: A Village Grain Storage Bin

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I

INTRODUCTION

At the request of the Government of Nigeria, a team of U. S. nutritionists and other scientists joined with a team of Nigerian scientists and conducted an evaluation of the nutritional status of a sample of the population of Nigeria during the period 1 February through 2 April 1965. The survey was sponsored by the Interdepartmental Committee on Nutrition for National Development (ICNND)[1/]. The U. S. team numbered 16 individuals and included specialists in agricultural production, toxicology and mycology, psychology and parasitology as well as physicians, nutritionists, and biochemists. An experienced dentist from the U. S. spent ten days in the field with the group to assist the Nigerian dentist on the team in standardizing his evaluations with those of other similar surveys. The Nigerian team consisted of physicians, a nurse, nutritionists, biochemists, and psychologists in addition to the dentist. Other members of the team included a British pediatrician from the University of Lagos and two members of the U. S. Naval Medical Research Unit No. 3, Cairo, Egypt. Two special consultants took part in the survey, a U. S. expert on liver disease and a professor of nutrition from the American University of Beirut, Lebanon, a consultant to the World Health Organization, who is a specialist in the relation of nutrition to diseases of the eye. Supporting personnel of several categories were also members of the group.

Thus, in addition to the evaluation of clinical and nutritional health of the population sample, the study included a survey of agricultural practices, food use and nutrient intake, the presence of mycotoxins in foods and their possible significance, the prevalence of parasitic infestation, and exploratory studies of the possible relation of nutrition to mental development and to disorders of the eye found in the country. The four larger regions of the country, the Eastern, Midwestern, Western, and Northern Regions, and the Federal Territory of Lagos were surveyed. The population examined in each area included people in villages, school children, women in prenatal clinics, and children at child welfare clinics, as well as members of the army and police training school. Dietary surveys were made in most of the same areas in which clinical examinations were conducted, and the school lunch program in Lagos schools was studied. Specimens for biochemical analyses were obtained from more than half the individuals having detailed physical examinations.

Purposes of the survey were to provide information of value in guiding improvement in the nutritional health of the people of Nigeria and to afford additional training and experience for personnel in technics of nutrition studies.

1/ On 1 July 1965 the ICNND became the Nutrition Section, Office of International Research, National Institutes of Health.

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II

BACKGROUND

Nigeria, located in West Africa, extends from the Gulf of Guinea on the south to the border of the Sahara on the north and has an area of about 357,000 square miles. It is divided into four Regions and the Federal Territory of Lagos, as follows:

Northern Nigeria	281,782	square miles
Western Nigeria	30,454	" "
Eastern Nigeria	29,484	" "
Midwestern Nigeria	14,922	" "
Federal Territory of Lagos	27	" "

Geography and Climate

Most of Nigeria has an elevation ranging from sea level along its 500-mile coast line on the Gulf of Guinea to 2,000 feet. There is a large plateau, the Jos Plateau, in the Northern Region ranging from 2,000 to 3,000 feet, with peaks up to 6,000 feet or higher. Most of the country is drained by the Niger and Benue Rivers. The Niger, with a total length of some 2,600 miles, enters the country at the northern part of the eastern boundary, flows southeast and south and enters the Gulf of Guinea through a large delta extending 20 to 60 miles inland as a network of small streams. The lower 200 miles of the Niger are navigable by shallow draft steamers throughout the year, and another 150 miles upstream are navigable during the rainy season. The Benue enters the country from the east and flows easterly to join the Niger some 250 miles north of its mouth. It is navigable by river steamers throughout most of its length. The Cross River and its tributaries drain the eastern part of the country. An area in the northeastern part of Nigeria drains into Lake Chad.

The country is divided into four latitudinal vegetation zones -- coastal, rain forest, open grasslands and, farthest north, a zone of scrub vegetation. The coastal region is swampy, partly fresh, partly salt, and is dominated by mangrove trees, with little solid dry land. This zone varies in width from a few miles to over 50 miles in the delta and is sparsely populated.

Inland from the coastal area lies a belt 50 to 100 miles wide of dense tropical rain forest consisting of evergreens in the south and deciduous trees in the northern, less rainy portion. Here logging produces mahogany and other hardwoods and much of the land has been cleared for cultivation.

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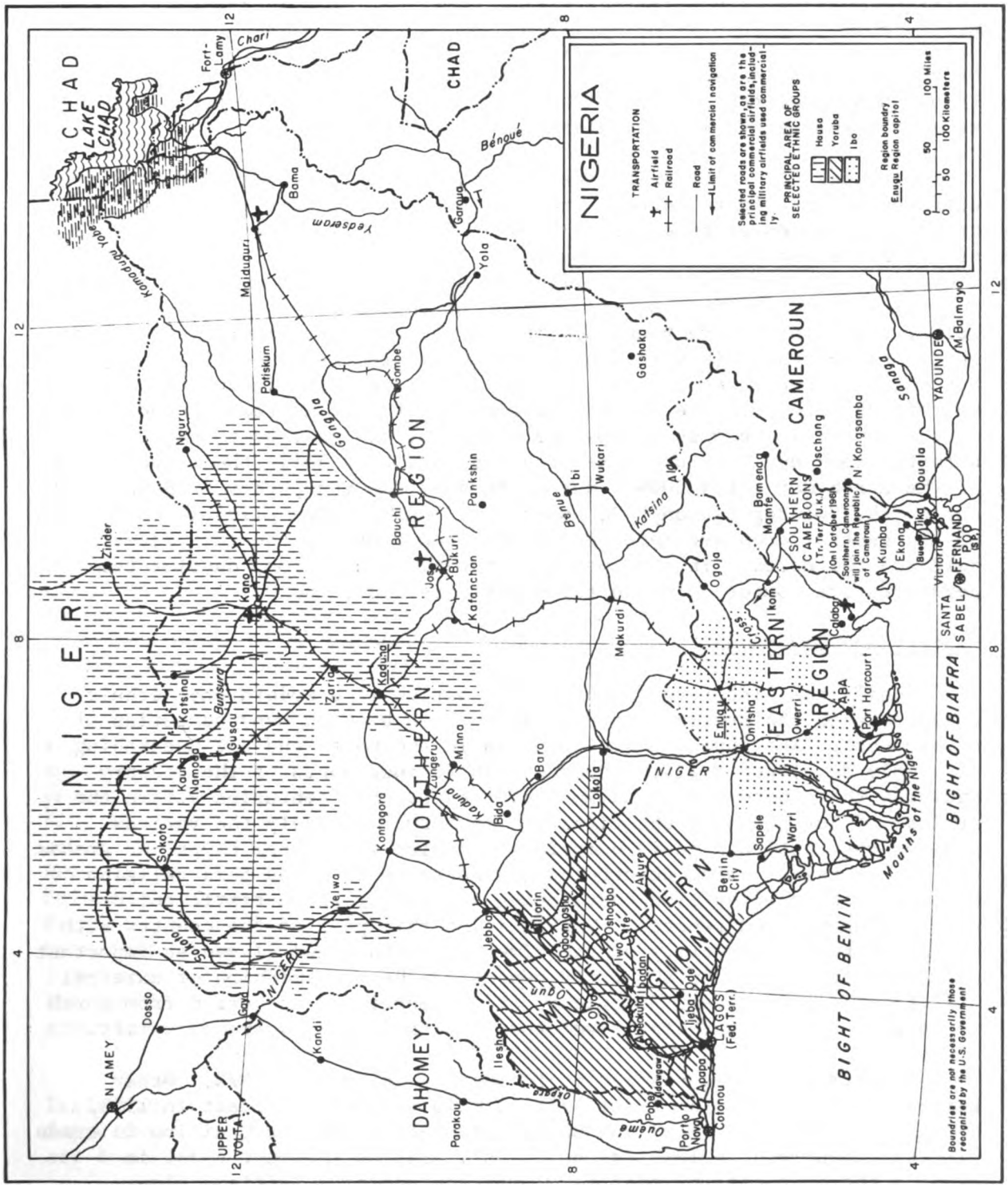

FIGURE 1. MAP OF NIGERIA

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There is a gradual change from this forest belt to the grassland belt, or savannah, which extends north some 300 miles in width. The grass is lush in the southern portion and becomes shorter in the northern, drier area. In this northern area the Jos Plateau rises and is covered by rolling grasslands, except in the southeast, where granite peaks rise to 6,000 or more feet. Across the extreme north of the country lies the zone of scrub vegetation which extends into the Sahara.

Although all of Nigeria lies within the tropics, there are marked differences in climate between the northern and southern parts. In the south the temperature varies between 70° and 100° F with an average around 80° F and the humidity is high. In all parts of the country there is a wet and dry season, with the heaviest annual rainfall in the coastal region. In the eastern portion of this region, including the delta, the rainfall may reach 170 inches for the year, most of it coming in the rainy season (May to January). Inland temperatures remain high but rainfall decreases from around 100 inches per year in the rain forest belt to 25 inches in the scrub area. Humidity also decreases, and in the northern area it becomes so low for a part of the year as to cause the skin to crack and the mucous membranes to dry up. While the temperatures of the north may reach 100° F during much of the year, they drop markedly during the "winter season," December and January. The climatic conditions of the central area are intermediate between those of the rain forest belt and the north. In some parts of the plateau region, daytime temperatures are comfortable and the nights are cool.

History and Government

While the history of Nigeria as a nation is a modern one, ethnic components of the present day population look back on many centuries of development. The chronicles of peoples in the north and the unearthing of highly developed artistic products in various parts of the country indicate that there were dynamic societies several centuries before the arrival of Europeans in the fifteenth century. Probably the various peoples who settled Nigeria came in successive waves from Egypt and Arabia and even Persia. Islam penetrated the northern part and this religion became established by 1500, developing a literary and artistic culture and leaving written records. Trade linked this part of the country with the Mediterranean as early as the time of Carthage and played an important developmental role. In the early centuries the transmission of external influences -- political, religious, and commercial -- occurred from north to south. In the south fewer records of its earlier years were left.

Nigeria was first visited by Portuguese sailors in 1472. Other Europeans followed. The first British ship visited the coast in 1553, and thereafter the British gradually attained a dominant position in trade with the country. In 1861 Lagos, a small area on the west coast including the port city by that name, was annexed as a British colony.

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During this century the British extended their trade into the interior and greatly expanded their government's sphere of influence. In 1885 a British "sphere of influence over Niger" was recognized at the Berlin Conference.

During the 19th century there occurred a movement of development and culture from south to north. European trading and missionary activities developed, and by the turn of the century social and economic leadership was evident among the southern peoples.

In 1900 the British established separate protectorates over Northern and Southern Nigeria. In 1914 these areas were incorporated into the British Crown Colony and Protectorate of Nigeria, which also included the original Colony of Lagos. In 1939 the southern provinces were divided into Eastern and Western Regions, and the three regions -- Northern, Eastern, and Western -- and the Territory of Lagos, came into being.

Beginning in 1923 various measures of self-government were granted, and in 1957 a complete federal form of government was established. On December 12, 1959, a new federal government was elected by popular vote. Under this government the country received its independence within the British Commonwealth of Nations on October 1, 1960. Prior to its independence, the Federation of Nigeria included the U. N. Trust Territories of the Northern and Southern Cameroons. In plebiscites administered by the U. N., the Northern Cameroons voted to unite with Nigeria, while the Southern Territory voted to join the Cameroon Republic. Thus, Nigeria came into being as an independent country by a democratic process with leaders knowledgeable in government.

In 1960 the Federation recognized the British Monarch as head of state who was represented by a Governor-General. The Governor-General appointed a Prime Minister as the chief official who, among other responsibilities, served as Chairman of a Council of Ministers representing the various areas of government such as defense, health, education, labor, and others. On October 1, 1963, the Federation became the Federal Republic of Nigeria. The country still remained a full member of the British Commonwealth, but the new Constitution created the office of President as head and abolished the office of Governor-General. The President could be elected for a five-year term by secret ballot at a joint session of the two houses of Parliament and could be reelected. The Parliament consists of a house of Representatives and a Senate. In accordance with the 1959 election, the House has 312 members.

Each Region of Nigeria has its own governor, premier, and bicameral legislature: a House of Assembly and a House of Chiefs. The latter represents the interests of the tribal chiefs. Within each Region there are local governments for provinces, cities, townships, and villages.

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Population, Language, and Religion

Nigeria is the densest and most rapidly growing country in Africa. A census made in 1962-63 showed a population of 55,654,000, a much larger figure than previously estimated. This represents a gain of nearly 80 percent over the figure arrived at by the census of 1952-53, assuming the two totals are relatively comparable as regards area included and degree of accuracy. The population is unevenly distributed geographically, with the lowest concentration in the arid regions. According to the 1962-63 census the population distribution by regions is:

Northern Region	29,788,000
Eastern Region	12,389,000
Western Region	10,278,000
Midwest Region	2,533,000
Federal Territory of Lagos	675,000

A comparison of these figures with those given earlier for the areas of the Regions indicates that the Northern Region, which has some 80 percent of the land area, has only a little more than half the total population.

On the basis of recent estimates, Ibadan, the capital of the Western Region, is the largest city with a population of around a million. Lagos, the Federal capital, stands next on the basis of a recent estimate of 500,000. Besides Ibadan, there are several other large cities in the Western Region, including Ogbomosho, Oshogbo, Ife, Abeokuta, Ilesha, and Oyo. Among the large cities in the Eastern Region are Port Harcourt, Enugu, the capital, and Aba. In the Northern Region Kano is by far the largest city.

While the urban population is expanding faster than that of the country as a whole, the large majority of the total are rural. Most of the rural people live in mud huts usually arranged to form compounds for the extended family group (father, sons and their families). Cities are overcrowded; two thirds of the inhabitants live in small dwellings on narrow, winding streets.

There are two main racial groups, Negroes and Fulani. There are about 200 different philologic groups, but these are united into four main groups through the use of common languages, namely the Hausa-speaking, Ibo-speaking, Yoruba-speaking, and Fulani-speaking peoples. The Hausa group is located in the northern part of the Northern Region; the Ibo live in the Eastern Region; the Western Region is dominated by the Yoruba, and the Fulani live in the Northern Region, both as city dwellers and as nomadic herdsmen.

The official language of Nigeria is English. It is the language of commerce and is spoken in all large cities and towns. The principal newspapers and magazines are printed in English. While it is estimated

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that several million of the people speak English with varying degrees of facility, there are some 200 vernacular languages, each of which is the mother tongue of a given ethnic group and is used as the every day medium of communication within the group, but cannot serve for communication with other groups.

The Islamic religion was introduced into Northern Nigeria in the 13th or 14th century. It has been estimated that some 45 percent of the population of the country are Moslems, most of whom live in the Northern Region. Christianity was introduced by missionaries following the coastal explorations and some 30 percent of the population are said to claim it as their religion. The rest of the population adhere to indigenous religions.

Transportation

For the population as a whole, walking is the common method of transportation. Mechanized transport is limited and expensive, and there are few draft animals. There are over 40,000 miles of roads, of which some one-sixth are tarred. Trunk A roads, maintained by the Federal Government, link Lagos with the regional capitals and other principal cities and with neighboring countries. Trunk B roads, administered by Regional governments, connect large towns with the federal road system. The other roads, some 75 percent of the total, administered by local authorities, are almost entirely dirt, many of them impassable in the rainy season.

The railway system is controlled by the Government. The network is approximately 2,500 miles in length, all single track and 3'6" guage. Main lines run northward from Lagos and Port Harcourt, joining at Kaduna and then proceeding north through Kano and Nguru. There are branch lines to railheads for export crops.

There are international airports at Lagos and Kano which are served by several major airlines. Air traffic is on the increase and is being extended to parts of the country not previously served.

Canoes, barges, and other boats serve for local transport along the swampy creeks, streams, and rivers. Shallow draft river steamers provide long distance transport on the Niger and Benue Rivers. For the country as a whole, water transport is less important than rail transport.

Education

Education is primarily under regional control. There are primary schools with courses lasting six or seven years. Secondary schools provide for five or seven years of education. Technical schools and teacher-training schools operate at both primary and post-secondary school levels.

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Universal primary education has been established in the Eastern and Western Regions, and in the Federal capital of Lagos. In the Northern Region universal primary education is provided in the city of Kano.

In 1961 there were 15,743 primary schools with an enrollment of 2,803,836 and 997 secondary schools with an enrollment of 168,238 (1). It has been estimated that enrollment in primary schools has doubled in the past ten years, and a large expansion is planned under the 6-year Development Plan. The present estimated literacy rate for the country as a whole is 20 percent and is much lower than this in the Northern Region.

In 1957 the Federal Government established the first institution of higher learning as University College, now Ibadan University, at Ibadan. Its medical school has a department of applied nutrition in which the London School of Hygiene and Tropical Medicine has a field training program for nutritionists and food technologists. The University also has a School of Agriculture and a School of Forestry.

The Nigerian College of Arts, Science, and Technology was established by the Federal Government in 1954, with branches in each Region, awarding degrees in engineering and other professional subjects. These branches were later absorbed into universities set up by the regions. In 1960 the University of Nigeria was established in Nsukka in the Eastern Region. It has a department of agriculture with which Michigan State University has a cooperative program. In 1961 the University of Ife was established in the city of that name. In 1962 the Ahmadu Bello University was set up in the Northern Region at Zaria. It has an agricultural and also a veterinary department. There is also a veterinary unit at Vom. Most recently, the Federal Government has established a university at Lagos which includes a medical school. There is a school of pharmacy in the outskirts of Lagos. The further expansion of university education is also an important part of the 6-year Development Plan.

Mining

The principal mineral resources of Nigeria are petroleum, tin, columbite, iron, coal, limestone, lead, and zinc. At present only tin, columbite, petroleum, coal, and limestone are being produced in commercially significant quantities. Nigeria is the sixth largest tin producer in the world, accounting for about 6 percent of the world's production, and it produces most of the world's columbite. The production of both these metals is centered around Jos in the Northern Region.

The petroleum reserves thus far discovered are located in the coastal area. Production of crude oil amounted to 13.3 million tons in 1965 and is on the increase. Nigeria is the only country in West Africa producing coal in commercial quantities. There is a large deposit near

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Enugu in the Eastern Region, and deposits have also been found in the Western and Northern Regions. Most of the coal produced is used within the country, but there is a small export.

Limestone deposits are found in all regions. Limestone is used for the manufacture of cement. A large deposit of iron ore, averaging 45 to 50 percent iron, is located near Lokoja in the Northern Region. A deposit of lesser purity exists near Enugu. The construction of a steel mill is planned and will be in production perhaps by 1970.

Manufacturing

Most of the manufacturing carried out in Nigeria for the production of goods for domestic consumption and the processing of products for export is on a small-scale basis, for there is little machinery or trained labor for large-scale operations.

Two large textile mills, one with an annual production of 40 to 45 million yards of bleached cloth, are in operation at Kaduna. There are two others near Lagos. Two cement plants are in operation and a third is under construction. There is a large aluminum rolling mill at Port Harcourt. The country also has a tin smelter and lumber plywood mills. Most of the internal demand for cigarettes is being supplied by three factories. Locally produced beer and soft drinks are replacing imports. There are several small groundnut mills in the Kano area. There are also small palm nut mills in the growing areas. Food manufactures include bakery goods, canned fruit and juice, margarine, flour (mill at Lagos), and canned beef (processing plant at Kano). Other manufactured products are leather, furniture, soap, footwear, ceramics, foam rubber mattresses, blankets, clothing, aluminum utensils, radios, light bulbs, and phonograph records.

A petroleum refinery at Port Harcourt was completed and went into production in 1965 with an annual capacity of 1.9 million tons of crude petroleum. A large-scale sugar plantation (6,500 acres) and refinery has been developed at Jebba in the Northern Region. The country is striving to increase its industrial operations as part of its 6-year Development Plan.

According to a report of the Nigerian Federal Ministry of Commerce and Industry for January, 1963, there are a total of 706 manufacturing plants in Nigeria, each plant employing ten or more persons, with a total labor force of 73,230 and manufacturing products classified in 46 categories.

Foreign Trade

Agricultural products provide some 60 percent of the country's exports. In 1965 these products had a value of about 450 million

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dollars (2). Of this, some 60 percent was provided by coca beans, palm seed and oil, and peanuts. Other important agricultural exports were crude rubber, cotton and cottonseed, hides and skins, and logs and lumber. Nonagricultural exports were crude petroleum and ores.

The principal imports of Nigeria are manufactured goods and machinery and transport equipment. Agricultural products make up about 12 percent of the value of imports (1). The principal agricultural imports are wheat and sugar. Nigeria's trade data do not include many of the cattle driven across the border from neighboring countries. A comparison of the figure of 12 percent for the proportion of the total imports supplied by agricultural products with the figure of 60 percent for the proportion of the total exports coming from agriculture reveals the large importance of agriculture in the nation's economy.

The General Economy and Economic Outlook

The gross national product increased from 1.9 billion dollars in 1950 to 2.9 billion in 1960, and it was estimated that it would increase to 3.4 or 3.6 billion in 1965, all figures at 1957 prices. This has meant a substantial increase in per capita income. The improvement in the economy has been greatly assisted by aid provided by the United States which totaled 61.9 million dollars from 1954 through 1963, mainly supplied during the last three years of this period (1).

Although the Federal and Regional governments have shown surpluses in their recurrent budgets in recent years, capital expenditures have increased steadily in connection with development programs. As a result, over-all budget deficits have been incurred in increasing amounts yearly. Total Federal and Regional government income amounted to 380 million dollars in 1962-63; current expenditures, to 339 million; and capital expenditures, to 179 million (1).

During 1963 and 1964 these capital expenditures were made largely as a part of the 6 -Year National Development Plan covering the period 1962-68, announced in March 1962. Actually there are separate but coordinated plans of the federal program and the programs of the regional governments. The over-all program is broadly designed to boost the economy of the country. The highest priority is given to agriculture, industry, training of manpower at both high and intermediate levels, and the stimulation of private industry. The estimated cost is expected to total 1,894.2 million dollars, of which the Federal Government is to provide 1,115 million, the balance being furnished by the Regions. It is estimated that some 38 percent of the total cost of the plan will be available from domestic sources. Half is being sought from foreign sources.

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Food and Nutrition

Data prepared by the U.S. Foreign Agricultural Service are presented in Table 1. It should be noted that these data apply to the years 1959-61 and to an estimated population of 39,400,000. Application of these figures to the present population would be limited. However, these data probably represent the general dietary pattern of today and thus provide useful information on the character and nutritive value of the over-all food supply. Almost all of the food consumed is produced within the country. In terms of calories, the small amount imported is more than balanced by exports (shelled peanuts and vegetable oils). The diet is largely vegetarian, supplied principally by two groups of foods--cereals and starchy roots (cassava and yam)-- accounting for about 78 percent of the calorie intake. Animal products and fish supply less than 3 percent of the calories and around 8 percent of the protein. Another 6 percent of the protein is furnished by pulses and peanuts. Milk is home-produced with the exception of a very small amount of the canned product. The vegetable oils are almost entirely palm oil. Although they are not given in the table, beer and wines are frequently listed as imports in dietary surveys. Presumably the data for bananas include those for plantains.

Data such as those in Table 1 are useful indicators of the food economy of a country and the general make-up of the national diet, although they apply to specific areas or situations among groups and individuals. This fact needs particular emphasis in the case of Nigeria with a large proportion of farm families, where what is eaten in a given area depends largely on what currently is being produced.

A number of nutrition surveys have been made in Nigeria. The most extensive and informative are those of B. M. Nicol which were carried out over a period of some 12 years (4-8, 10, 11). From 1954 to 1957 a comprehensive survey was made of the foods consumed and the calorie and protein intakes in five vegetation zones extending from the extreme north to the mangrove swamp in the south (Figure 2). Farm families in seven locations chosen to be representative of the dietary patterns and climatic conditions of the respective zones were studied. Food consumption was measured for 10 days at three periods -- shortly after the harvest of staple foods, midway between harvest and the next planting, and during the two months before the next harvest.

The first publication (4) deals with foods consumed and calorie intakes. The mean daily intakes of individual foods for adults (over 12 years) at the different locations reflect the dietary patterns in different zones. In the two southern zones, the staple food was yams. Little food of animal origin was consumed. Intakes of legumes, nuts, green leafy vegetables, and fruits were higher than elsewhere. In the

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TABLE 1. FOOD BALANCE, NIGERIA 1959-61[1/]
(Estimated Population 39,400,000)
(Condensed from a Table Supplied by C.A. Gibbons of the Foreign Agricultural Service, U.S.A.)

Product	SUPPLY				UTILIZATION FOR FOOD				
	Production	Imports	Exports	Total Supply	Total[2/]	Per Capita			
						Per Year		Per Day	
						Kilograms	Calories	Protein gm	Fat gm
	1,000 metric tons								
Wheat flour		58		58	58	1.5	14	0.5	0.1
Corn	1,008			1,008	816	20.7	204	5.3	2.3
Sorghum and Millet	3,133			3,133	2,055	52.2	491	13.9	4.3
Rice	354	2		356	225	5.8	57	1.1	0.2
Other cereal		9		9	9	0.2	2	0.1	
Total cereals						80.4	768	20.9	6.9
Sugar	43	73		116	116	2.9	28	0.1	
Cassava	9,750			9,750	8,775	222.7	665	5.5	1.2
Yams	11,000			11,000	7,700	195.4	482	11.2	1.1
Pulses	351		8	343	314	8.0	76	4.9	0.5
Peanuts, shelled	769		448	321	132	3.4	51	2.4	4.0
Other vegetables	1,050	5		1,055	845	21.4	13	0.8	0.1
Bananas	1,617			1,617	1,374	34.9	72	0.8	0.3
Other fruits	635			635	540	13.7	12	0.2	0.1
Meat	257	3		260	260	6.6	27	2.5	1.8
Fish	125	39		164	156	4.0	7	1.0	0.3
Milk	335	9		344	344	8.7	18	0.8	1.0
Eggs	29			29	29	0.7	3	0.2	0.2
Vegetable oils	602		227	375	375	9.6	232		26.3

1/ "The results of a recent census indicate a population estimate of 52,200,000 for mid-year, 1960. Because subsistence crop production is based in part on estimated per capita consumption, the estimated production of these crops would be increased if the new figures are accepted."

2/ Total supply less nonfood use, with the following extraction rates applied to cereals: corn, 95; sorghum and millet, 90; rice, 70.

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other locations staple foods were millets and sorghum, supplemented with more meat, fish, or dairy products. The nutrient composition of the average daily diets for the seven locations is presented in Table 2.

Calorie requirements were calculated from the methods suggested by FAO. In general, good agreement was found between intakes and needs of adults whose lives were not associated with great physical exertion, except where the harvest had been poor. On the other hand, children did not receive enough food to meet their calorie needs. It was noted that the head of the family receives food before the women and that the children come last.

The second report (5) of this survey deals with protein and amino acid intakes by adults in Jarawaji near Lake Chad where the staples of the diet were millets and sorghum, and in Bero-Okuta, an area where yams provide the basic food. For the families eating millets and sorghum, the mean daily protein intake of adults was 85 gm. Their protein score was 77. The corresponding figures for those eating yams were 51 gm and 50.

Another report (6) compares the health of children of three tribes living in the bush with that of the offspring of educated families living in a city (Kaduna). Evidence of deficiencies of vitamin A and of riboflavin was found. None of the children except those living in Kaduna consumed enough food to meet energy and nutrient requirements, even though diets of adults supplied sufficient calories.

The staple foods in the northern three zones (see Figure 2) are millets and Guinea corn (a sorghum). Cowpeas, rice, and groundnuts are important subsidiary foods in the Savannah. Cassava is an important supplement in the first zone and fish in the second. In the third zone important subsidiary foods are Indian corn, rice, sweet potatoes, yams, cassava, locust beans, palm produce, and groundnuts. In the southern three zones the staple foods are yams, cocoyams, and cassava. Important subsidiary foods are Indian corn, locust beans, palm produce, rice, and Guinea corn.

The intakes of calcium are in the "acceptable" range, and iron intakes are "high" (See Appendix Table 4). Endemic goiter is present in several regions in Nigeria.

Collis and associates of the Institute of Child Health of the University of Ibadan have made comprehensive surveys in villages in three different areas in the Ilesha Division of the Western Region (12). The average number of children per mother was 4.2 and the death rate in children up to puberty was 468 per 1,000 births. Only 54 percent of the population surveyed was engaged in food production, and movement into towns by younger workers to nonagricultural occupations was reducing the number of future food producers. Yams and cassava provided the staple foods of the diets, except at one location where they were largely replaced by cereals (13). Diets were habitually poor in protein and only

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TABLE 2. NUTRIENT COMPOSITION OF THE AVERAGE DAILY DIETS EATEN BY RURAL NIGERIAN PEASANT FARMERS IN SEVEN DIFFERENT AREAS OF THE COUNTRY (Nicol, 4)

Village	Sex and age (years) group	Calories	Protein		Fat	Calcium	Iron	Vitamin	Thiamine	Riboflavin	Nicotinic acid	Ascorbic acid	
			Animal gm	Vegetable gm	gm	mg	mg	A I.U.	mg	mg	mg	On the raw basis mg	With allowance for cooking losses mg
Jarawaji	Men over 12	2,980	29	83	37	1,400	56	900	3.6	1.1	27	13	9
	Women over 12	2,650	24	68	33	1,100	49	1,200	3.2	1.1	22	16	12
	Children: 4-6	1,380	22	34	23	1,100	26	1,000	1.6	0.6	13	12	6
Tangaza	Men over 12	2,250	2	71	29	300	24	1,400	2.2	0.9	19	7	3
	Women over 12	1,520	1.5	46	19	260	16	1,200	1.5	0.6	13	12	5
	Children: 7-9	1,390	1	42	21	230	16	900	1.5	0.6	13	8	4
	4-6	1,180	1	35	16	200	13	800	1.2	0.5	11	8	4
Bunga	Men over 12	2,920	11	83	40	880	37	4,200	2.9	1.4	24	133	44
	Women over 12	2,120	8	62	28	720	26	4,000	2.1	1.0	17	65	30
	Children: 10-12	1,880	6.5	62	28	550	22	3,400	2.0	0.9	14	68	17
	7-9	1,790	5	52	26	490	21	3,700	1.7	0.8	14	85	23
	4-6	1,480	4	43	21	380	16	3,000	1.5	0.7	11	57	17
Tungan Maidubu	Men over 12	2,910	16	106	34	560	43	2,800	4.1	1.5	31	18	6
	Women over 12	2,520	8	96	26	470	36	2,750	3.9	1.3	27	39	22
	Children: 10-12	1,820	6	72	18	360	28	2,000	3.0	0.9	20	30	16
	4-6	1,110	3	47	11	280	16	1,000	1.8	0.5	10	22	9
Langai	Men over 12	2,550	15	77	45	610	29	4,100	2.2	1.3	24	43	14
	Women over 12	2,110	10	72	40	560	25	3,200	1.9	1.0	22	52	21
	Children: 10-12	2,120	15	61	43	530	26	3,900	1.9	1.1	21	53	19
	7-9	1,440	15	36	36	340	18	2,700	1.8	0.7	15	42	14
	4-6	1,180	8	33	24	360	15	2,700	1.1	0.7	11	25	9
Bero-Okuta	Men over 12	2,060	1.5	50	14	460	19	1,600	1.7	0.7	12	160	35
	Women over 12	1,680	1.5	40	12	350	15	1,500	1.4	0.5	9	122	31
	Children: 7-9	1,400	1	34	15	280	13	1,500	1.2	0.5	9	101	25
Mbanege	Men over 12	2,390	3	59	31	640	23	11,880	2.1	1.0	17	216	54
	Women over 12	1,950	2.5	51	28	540	22	13,000	1.7	0.8	17	178	45
	Children: 7-9	1,520	1	38	22	370	15	7,100	1.3	0.5	10	144	37
	4-6	1,210	11	28	10	250	10	3,300	0.8	0.3	6	90	22

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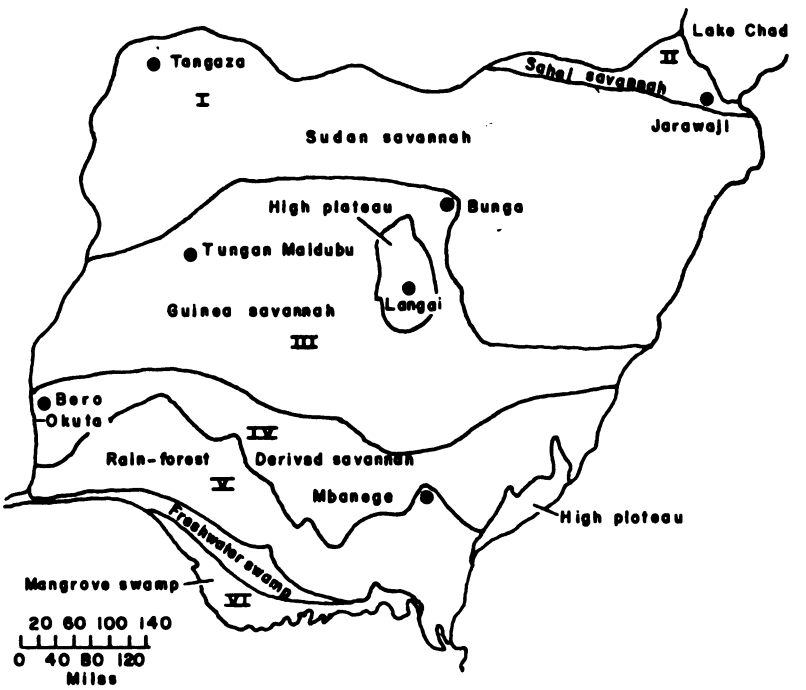

Vegetation zones of Nigeria showing the situation of the villages in which the studies of food consumption were made. (Nicol, 4)

FIGURE 2

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occasionally adequate in calories. There were wide seasonal variations in the intake of calories and protein, related to time of harvest and economic conditions.

The growth rates of the children were low compared with those of well fed children of educated parents seen in the University Hospital. The latter were some 6 inches taller and 10 pounds heavier at three and one-half years of age, and their growth rates were similar to those reported for American children. Results of blood and fecal examinations of the rural children showed a high rate of malaria, loa-loa, ascaris, and hookworm. Three hundred fifty children were treated for kwashiorkor in the Mission Hospital over a period of 15 months.

Collis and associates made a third study (14) of a different cultural group in the Pankshin Division of the Northern Region on the Jos Plateau. The staple foods were largely cereals. Calorie and protein intakes were adequate. Intakes of calcium, iron, thiamine, and riboflavin were also satisfactory. Of 600 persons examined, 50 showed definite signs of goiter. The heights and weights of the children were greater than those of the children in the Ilesha area. Infestation and infection rates were somewhat lower. Nevertheless, child mortality rate in Pankshin was found to be high, due to measles, pneumonia, dysentery, and other infectious diseases.

Some informative dietary and clinical surveys have recently been carried out in the Western Region (15, 16, 17).

Health and Medicine

Most of the diseases of the tropics, such as malaria, yellow fever, sleeping sickness, leprosy, yaws, and tropical ulcer are found in Nigeria, although they have been brought increasingly under control with the gradual extension of health and sanitation facilities. Until recently no vital statistics were kept. Infant and childhood mortality rates are estimated to be very high and only about 50 percent of liveborn children live to the age of five years. In 1960 the crude death rate in Lagos was 11.8 per 1,000, birth rate 60.2 per 1,000, and infant mortality rate 62.9 per 1,000 live births.

Diseases resulting from contaminated food and water are related to poor sanitary facilities. With few exceptions water supplies are unsafe to drink, and methods of the disposal of body excreta and refuse contaminate both food and water. Food inspection is a responsibility of the regional governments, but it is limited to the larger urban centers. Food handling in markets and food preservation leave much to be desired.

Folk medicine continues to be important to most of the population. Modern medical facilities are available only in urban areas. Often practitioners of Western medicine find they are most successful if they adapt modern methods to traditional remedies and beliefs.

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There is a total of 16,729 hospital beds in Nigeria, in 2,180 facilities. Standards in the Mission and Regional Hospitals are generally good. The 510-bed Teaching Hospital in Ibadan is considered the finest hospital in Africa. There are several medical laboratories, some carrying out research and some producing vaccines. There are about 1,000 registered doctors and 40 dentists, about half of whom are employed by the Government at various levels. The others work for Missions, commercial concerns, and in private practice. There are about 5,300 registered nurses, 5,000 midwives, and some 500 pharmacists and druggists.

Government health services are provided by the Federal and Regional units. The organization in each region is similar to that of the Federal government. Each has a Minister of Health with a Department of Medical Services. Under the Regional Governments medical services are administered by districts. Leprosy services, sleeping sickness services, and health education programs, as well as preventive medical services, are provided by the regional or local levels. Regional governments have devoted significant sums to expanding medical facilities. Both WHO and UNICEF have furnished technical and financial assistance to raise health standards.

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III

GENERAL DESIGN OF THE SURVEY

The nutrition survey was designed to assess the nutritional situation in Nigeria, to identify major needs, and to provide information which will aid in the correction of identified needs. During the time available for this mission, it was impossible to study all of the problems in depth. Accordingly, the survey is to be regarded as a step in the establishment of a continuing national nutrition program which will provide for extension of studies in depth in order to amass the data ultimately required to understand fully the nutritional problems of Nigeria, an essential for the sound design of corrective measures. So viewed, the positive gains of the nutrition survey became important, and the areas of incompleteness represent challenges for future investigations -- not flaws which detract from the gains.

The plans for this survey and the interpretation of the data are based upon the philosophy that nutrition is a health measure practiced two, three, or more times daily, which must be correctly practiced repeatedly throughout a lifetime of changing requirements, and that several corrective measures more often than a single measure must be instituted when a specific need is identified. These corrective measures include widely separated disciplines and customarily involve responsibilities of the Ministries of Agriculture and Natural Resources, Animal and Forest Resources, Education, Economic Development, Transportation, and Health.

The sites selected for survey were intended to include each of the topographical segments of Nigeria and at the same time allow a more intensive appraisal of the Eastern, Western, and Northern regions of the country and the Federal District. The following table defines all survey sites:

Topographic Region	Survey Site
Derived Savannah	Ilorin Nsukka Enugu
Savannah	Zaria
Plateau	Jos Pankshin
Urban Federal District	Lagos
Rain Forest	Ibadan Asaba
Coastal	Epe Port Harcourt

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The plan of the survey was essentially that followed in other ICNND nutrition surveys, and the methods were those detailed in the Manual for Nutrition Surveys (1) prepared by the ICNND, as revised in keeping with experience in other countries and adapted to the special needs of and conditions in Nigeria.

An estimate of food available has been derived from the information made available by governmental and international agencies supplemented with direct observations. The studies of food control and regulation were made through direct visits by consultants and interviews with responsible, knowledgeable persons. While the figures given may vary some from those made by some particular agency or source, they represent considered judgment of approximations after reviewing all available data. The limitations of the figures are appreciated.

Clinical and biochemical studies were obtained from families brought together at a village center. In obtaining the examinees, an effort was made to include a proportionate sample in different age-sex categories. At each site the village chief announced the arrival of the survey team in the community and invited family groups to come to be examined. The families seen are not considered to be a random sample of the population at any of the sites. Male adults frequently were at work and did not accompany family groups. In some instances children were away at school. For these reasons, whenever possible, school children and employee groups were invited to participate separately from family groups.

Infants and children less than five years of age were examined by team pediatricians. The record of pediatric examination also provided information concerning breast feeding, the mother's reproductive history, and infant mortality rates. All adults and children five years of age or older were given abbreviated physical examinations by team physicians. A subsample of the total group, usually every fourth individual, was examined more extensively in the detailed physical examinetion. Specimens of blood, urine, and stools were obtained at random on approximately half of those examined in detail. These specimens were transported in ice or a preservative and arrived at the survey laboratory at Ibadan within 8 hours for analysis. The procedures of biochemical analysis are described in the Manual for Nutrition Surveys (1). Approximately 1,200 dental examinations were made and 18 samples of drinking water were obtained to assess their iodine and fluoride contents.

A similar plan was employed in investigations of special groups such as school children, military personnel, police cadets, and pregnant women. Such subsampling at times leads to minimal numbers of observations within a category which at times makes it difficult to generalize about the observations. Nonetheless, even in these latter cases, the data are useful indicators and may point the way for fruitful subsequent study. Hence, such data are presented in the report as "screening" probes, not as conclusive studies.

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Nutritionists recorded dietary histories and made detailed observations, weighed food, and prepared sample meals for chemical analysis in homes, boarding schools, and military messes. Some 90 dietary interviews of families and housewives were held, and 68 surveys of family dietaries and 4,665 of school dietaries were made. Four military messes were surveyed, including quantitative determination of the food used during the days of the study, preparation losses, plate waste, estimates of cooking losses, and collection of aliquots of food for chemical analysis.

The initial report of the activities was presented to the Government of Nigeria upon completion of the study. A preliminary report was subsequently discussed in full with representatives of several ministries and with the staffs of international agencies working in Nigeria before this final report was prepared.

The continued availability in Ibadan of the Nutrition Laboratory established during the survey provides a resource which is expected to have extensive service in follow-up studies and continuing nutrition programs in Nigeria.

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IV

AGRICULTURE, FOOD PRODUCTION, AND FOOD AVAILABILITY

Agriculture

Nigeria is a tropical land comprising about 356,000 square miles with a population of about 56,000,000. From south to north are strips of coastal swamp, tropical rain forest, derived savannah, and savannah, (Fig. 2) with typical rainfall patterns ranging from 80-140 inches in the south, 40-80 inches in the middle belt, and 20-40 inches in much of the north.

Perhaps 75 percent of the population of Nigeria is engaged in agriculture, and about 60 percent of the national income is derived from agriculture and forestry. Manufacturing accounts for less than 5 percent of the national income, while perhaps half the total funds available to the government is derived from import and export duties. Agricultural products account for about 60 percent of the total exports. The following export data illustrate the importance of this trade.

TABLE 3. NIGERIAN EXPORTS, 1963 [1/] and 1965 [2/]

Commodity	Value (£ Million) [3/]		Percentage of total export	
	1963	1965	1963	1965
Groundnuts and products	45.88	52.7	24.8	20.0
Cocoa	32.36	42.5	17.5	16.1
Palm produce	30.19	40.0	16.4	15.2
Cotton	10.95	7.5	5.9	2.8
Hides and skins	4.20	5.6	2.3	2.1
Petroleum	20.14	68.0	10.9	25.8
Rubber	11.77	11.0	6.4	4.2
Timber and plywood	7.84	6.6	4.2	2.5
Others	21.50	30.0	11.6	11.4

1/ Adapted from Review of External Trade, Nigeria 1965, Federal Office of Statistics.
2/ Some Observations on Nigeria's External Trade, Balance of Payments, and Government Revenue in 1965. U.S. AID/Nigeria, 23 February, 1966.
3/ £ = pounds.

Agricultural practices in Nigeria are still largely traditional. The prevailing system is "bush-fallow" in which a plot of land is cropped for a few seasons until fertility has declined to an unproductive level. It is then abandoned to fallow. Bushy vegetation and scrub forest are allowed to grow for an extended period. This may be 5 to 20 years

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depending on the character and basic fertility of the soil, and increasingly upon the demands of population for food. At the end of the fallow period, the vegetation on the plot is cut and burned, thus returning to the soil mineral nutrients which the deep rooted plants of the fallow have derived from the deep layers of the soil.

This system has provided, by and large, a dependable subsistence with a small surplus for trade. Population pressure is, however, beginning to weaken the system, because the demand for food exceeds the productivity of the traditional rotation. In an effort to increase productivity, the fallow period is shortened. Land is in cultivation more of the time, fertility is reduced, and erosion is speeded.

Land in much of Nigeria is under tribal ownership, use of specified areas being to some degree a heritable right. The areas cultivated by a family vary, but in general are quite small. In the Southern part of the country, fewer than 2 percent of the farms are larger than 10 acres; 90 percent are smaller than 5 acres. In the North, holdings are somewhat larger. The smallness of the operations precludes use of mechanized methods, and the hoe is the principal cultivating tool.

Most farms produce for subsistence, with incidental attention given to cash crops. There is much interplanting of cash and subsistence crops, such mixed cropping occurring on perhaps half the cultivated acreage. The pattern of land utilization varies by region. The most intensive usage is in the Eastern Region where population pressure is greatest. There over 20 percent of the land is in farm crops with over 40 percent in bush fallow. Main crops are cassava and yam, with cocoyams, sweet potatoes, rice, maize, and vegetables of some importance. Tree crops, primarily oil palm, rubber, and cocoa, occupy only about 3 percent of the land; forests about 10 percent; uncultivated bush pasture and wasteland about 20 percent.

The Western (including Midwestern) Region has a similar pattern of land usage, but the land is less intensively utilized than is that of the Eastern Region. About 10 percent of the land is under farm crops and about 7 percent under tree crops, again largely cocoa, palm, and rubber. About 20 percent is in bush fallow, 16 percent in forests, and nearly 45 percent in uncultivated bush pasture and wasteland.

In the North, farm crops -- primarily millet, guinea corn, and groundnuts, with rice, vegetables, cotton, and root crops of less importance -- occupy about 7 percent of the land. Another 9 or 10 percent is in bush fallow. Tree crops are unimportant, while forests (supplying largely firewood) occupy over 35 percent of the area. Uncultivated pastures and wasteland account for about 45 percent of the total.

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There has been little commercial production of livestock products. In the south, animal production is severely inhibited by trypanosomiasis. There are indigenous breeds of dwarf cattle and goats, sheep, and scavenger poultry, and swine throughout the south, but production and utilization of products has been limited.

The cattle-producing enterprise in Nigeria is very largely in the hands of the nomadic Fulani in the Northern Region. It has not been organized as a commercial meat- or milk-producing enterprise, and those products have been of secondary interest to the Fulani.

Estimates of livestock numbers in the country are crude, but the following gives at least a general idea of the distribution of domestic stock.

TABLE 4 . ESTIMATED LIVESTOCK POPULATION IN THOUSANDS, NIGERIA, 1963 1/

Species	Northern Region	Eastern Region	Western and Midwestern Region	Total
Horses	431	-- 2/	--	431
Donkeys	2,085	--	--	2,085
Camels	17	--	--	17
Cattle	10,256	434	169	10,859
Goats	14,317	4,684	2,204	21,205
Sheep	4,448	1,751	1,035	7,234
Swine	118	161	401	680
Poultry	47,716	14,264	10,060	72,040

1/ Based on FAO estimates
2/ The symbol "--" indicates only insignificant numbers

Food Production, Import, and Availability

Food Production

The primary staple food crops of Nigeria are the starchy roots in the south and guinea corn (sorghum) and millet in the north. Production estimates are only approximate, but average annual production of the most important food crops appears to be somewhat as follows:

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TABLE 5. AVERAGE ANNUAL PRODUCTION OF FOOD CROPS, NIGERIA

	1,000 long tons	
Cassava (Manihot utilissima)	4,200	tubers
Yams (Dioscorea sp.)	9,700	"
Cocoyams or taro (Colocasia esculenta)	900	"
Sweet potato (Ipomaea batatas)	100	"
Guinea corn (Sorghum sp.)	2,750	grain
Millet (Pennisetum typhoidum)	2,460	"
Maize (Zea mays)	800	"
Rice (Oryza sativa)	125	paddy
Groundnut (Arachides hypogaea)	800	shelled nuts
Bambara groundnut (Voandzeia subterranea)	48	" "
Beans (mainly Vigna sinensis and Phaseolus sp.)	700	dry beans
Soyabeans (Glycine max)	27	" "
Sesame (Sesamum indicum)	36	seed
Palm oil	480	
Bananas and Plantains (Musa sp.)	1,650	
Melon (various)	60	seed
Okra (Hibiscus esculentus)	16	
Onions (Allium cepa)	60	
Sugar (crude sugar and sugar equivalent of chewing cane)	50	

In addition, citrus fruit, particularly oranges and grapefruit, pineapples, tomatoes, carrots, peppers, leafy vegetables, Irish potatoes, pawpaws (papaya), mangoes, and other cultivated and wild fruits, vegetables, and seeds are widely available. Cultivated grains locally known as acha (Digitaria exilis) amd tamba (Eleusine corocana) are grown in the plateau area. They do not produce heavily but are adapted to the plateau and are relied on by many as the staple food. (See Appendix Tables 1 and 2 for lists of plants used as food in Nigeria.)

The production of foodstuffs of animal origin is widespread, but the level of production is difficult to estimate since much of it is for home consumption. The estimates of annual production presented here are based primarily on FAO data.

TABLE 6. MEAT PRODUCTION, NIGERIA

Animal	Carcass weight (1,000 long tons)
Cattle	182.5
Goats	59.5
Sheep	28.5
Pigs	17.5
Poultry	48.5

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Egg production for human consumption is estimated at over 50,000 long tons of hen eggs and an unestimated quantity of guinea fowl eggs. Milk production for human consumption is about 600,000 long tons annually, and commercial fish production is about 60,000 long tons.

Other local sources of animal produce include game, insects, crustacea, snails, and locally caught and consumed fish.

Food Imports

The major food imports of Nigeria are grain products, primarily wheat, and fish, primarily stockfish. The level of important food imports is indicated in the tabulated information.

TABLE 7. FOOD IMPORTS, NIGERIA

Commodity	Approximate annual import (1,000 long tons)
Wheat and flour (as wheat)	90
Stockfish (as fresh fish)	140
Canned fish (as fresh fish)	3
Frozen fish (as fresh fish)	2
Milk, condensed	12
Milk, dry	3
Meat and meat preparations	2
Sugar	60

Food Exports

Groundnuts, groundnut oil, and groundnut cake constitute the most important export of food from Nigeria. Palm oil and palm kernels are also of importance. The principal food exports are:

TABLE 8. FOOD EXPORTS, NIGERIA

Commodity	Approximate annual export (1,000 long tons)
Groundnuts	600
Groundnut cake	85
Groundnut oil	65
Palm oil	125
Palm kernels	380

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Food Availability

From the foregoing, rough estimates of food available for consumption can be made. Food balance sheets, as usually constructed, are not presented because of the lack of information about the extent of use of fruits, vegetables, and locally produced foods in general.

TABLE 9. ESTIMATED AVAILABLE FOODSTUFFS (1,000 LONG TONS)

Food item	Production	Import	Export	Available
Starchy roots and fruits[1/]	16,550	--	--	16,550
Cereal grains	6,135	90		6,225
Legumes and other seeds	1,671		750	921
Palm oil	480		125	355
Sugar	50	60		110
Meat (fresh carcass basis)	337	2		339
Fish (fresh basis)	60	140		200
Milk (fresh basis)	600	48		648
Eggs	50			50

1/ Plantain and bananas

If these amounts of foodstuffs were all used as food, they would supply the indicated approximate daily amounts per capita:

TABLE 10. ESTIMATED NUTRIENTS AVAILABLE PER CAPITA PER DAY FROM AVAILABLE FOOD SUPPLY

Food item	Grams	Calories	Protein (gm)
Starchy roots and fruits	830	1,000	12
Grains	310	1,085	28
Legumes and other seeds	50	220	8
Palm oil	20	176	--
Sugar	6	23	--
Meats	17	20	4
Fish	10	10	2
Milk	32	21	1
Eggs	3	--	--
Totals		2,555	55

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The estimates do not take into account the wastage of stored products caused by insects and other pests nor the materials used for purposes other than for food, e.g., seed, animal feed, and industrial uses. Actual intakes of many of these products are considerably less than indicated because of these losses and uses. On the other hand, the estimates do not take into account intakes of fruits and vegetables and of foods gathered from nature, because estimates of production and use are not generally available.

If the estimates of available foods reflect actual availability, it appears that the energy supply is adequate; but because of inequities of distribution there is probably a limited amount of calorie undernutrition. Protein supplies, particularly supplies of animal protein, are low. One would expect protein undernutrition to occur widely in vulnerable segments of the population. From these crude estimates, nothing can be deduced concerning total vitamin and mineral intakes. Fruit and vegetable intakes are reportedly low, however, and, at least seasonally and perhaps geographically, there are probable deficiencies of some nutrients.

Problems and Progress in Food Production and Supply

As noted, the traditional system and structure of agricultural production in Nigeria have met to a reasonable degree the caloric needs of the population, and there is as yet no absolute shortage of land for agricultural production. The problems of supplying food, then, are, for the short term, those of improving availability and quality of food. For the longer term, the problems are more difficult and involve the reorganization of the structure of agriculture and food distribution so as to feed the increasingly urbanized and industrialized population.

Short-Term Problems and Progress

Those concerned with agricultural production in Nigeria are well aware of the technical problems to be faced in improving the quality of the food supply. In plant production they include problems of soil fertility, improved varieties of familiar crops and introduction of new crops, and pest and disease control. Active research and demonstration work is sponsored by Federal and Regional agencies, universities, and foundations in all these fields.

In animal production, the overriding obstacle to increase is disease. Much of the country is denied commercial production of cattle and swine by trypanosomiasis. Other diseases may be as devastating but in general are more easily managed, and in fact many are becoming increasingly controlled.

The immediate nutritional needs of Nigeria, as noted, are primarily protein and probably some of the vitamins. Important research and developmental efforts are, accordingly, being put on increasing supplies of these nutrients.

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Legume Seeds. These are a good, acceptable, and generally cheap source of protein in Nigeria. Cowpeas are particularly popular. Research effort is directed at improved varieties, cultural methods, and pest control. The most limiting factor in production is insect damage. Also of great importance concerning availability are problems of storage. Within a few months after harvest, most of the beans in the market are heavily damaged by insects. Weight loss is estimated at up to 30 percent. Since sales are by measure rather than by weight, the food purchased per unit spent is reduced by a like amount. Continued and increased effort to find effective measures to protect stored products is necessary.

The increased use of groundnut presscake or flour is advocated to improve protein intake. At present, most groundnuts are exported or, after the oil is extracted, the cake is exported. If the cake is to be retained in Nigeria for human consumption, investigation into sanitary processing and storage must be emphasized. There are producers of food-grade groundnut flour in Nigeria, but most processors produce material only for animal feed. Of particular concern is the prevention of infestation with toxin-producing molds.

Cereal Grains. The substitution of cereal grains for the root crops that now constitute the principal foods of the southern areas of Nigeria would do much to correct the protein lack that now exists. It is not likely, however, that complete substitution will soon occur, nor perhaps wise to advocate that it should. The root crops produce energy-supplying food more cheaply than can the grains, and they fit the traditional agricultural and food consumption patterns of much of the population. Increased cereal grain production and consumption are, nevertheless, goals of agriculturists in all Regions. Research on varieties and soil fertility requirements is widely supported. Of particular importance are the development of rice production and breeding programs for maize and other major cereals. The program to replace acha and tamba with higher yielding grain crops in the plateau area is also of interest.

As with the legume seeds, insect damage to the stored grain is a major problem to be overcome. Losses of stored maize within a few months after harvest are estimated at 20 to 40 percent. Research on effective and economical protection of stored products has long received attention in Nigeria. Efforts should be continued and intensified.

Fruits and Vegetables. Although fruits and vegetables are grown widely, estimates of average consumption are about 25 gm per person per day. This figure may be much in error. Efforts to increase production and consumption of these foodstuffs are just beginning. There are experimental horticultural farms and plots where the primary effort is on variety trials. There is much scope for development of market gardens around the larger cities and the possibility of expanded commercial production of citrus fruit, bananas, pineapples, and perhaps mangoes and papaya, for domestic and foreign markets. In the villages the production of fruits and vegetables is largely carried on in the compounds and is

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under the care of the women. Gardening is being stressed in the preparation of home economics extension workers, so that emphasis will be given to this phase of food production. Another area needing and receiving some attention is that of production and protection of vegetable seed stocks.

Animal Products. The production of cattle and swine is limited in much of Nigeria by trypanosomiasis, and until the tsetse fly is controlled or effective prophylaxis is developed, the production of these animals will be curtailed. Many other animal diseases and parasitic infections abound and are of economic importance. Much research on disease control and widespread field operations are under way to overcome these conditions, and improvements are evident.

Beef is the most widely consumed meat in Nigeria, but its production and marketing are very inefficient. Animals when marketed are twice as old and half as heavy as those in many other beef production enterprises. The annual take-off of cattle is no more than 10 percent as compared to 25--30 percent elsewhere. There are many causes for the inefficient production, but the underlying one is the traditional structure of cattle production. The main source of beef is the herds of the Fulani. Since the herds are not kept as a means of food production but rather as property, little effort to produce meat economically or efficiently is made. In addition the marketing system is wasteful. Short-term efforts to improve the source of beef will have only limited effect, and the country must look to long-term efforts if beef production for domestic use and export is to be greatly improved. The short-term efforts include disease control, improved husbandry practices, the development of potable water supplies, and improvement of marketing and slaughter facilities.

Tsetse fly control is of primary concern. Control on the periphery of the fly belts has been successful, control efforts elsewhere less so. Thus for most of the year, cattle production is limited to the northern fly-free areas of the country. Other diseases of importance are rinderpest, which is in reasonable control; contagious bovine pleuropneumonia, which is relatively well controlled by testing, vaccination, control of stock movements, and slaughter with compensation; streptothricosis, a mycotic infection for which no effective control has been developed; foot and mouth disease; internal parasitic infections, particularly cysticercosis and infestation by flukes; and external parasites.

Efforts to improve husbandry practices in the present system of cattle production have included provision of watering facilities, research on range improvement and conservation of forage, and demonstrations of range management. One interesting device is the cooperative arrangements being encouraged between farmers and herdsmen that would provide grazing for herds on fallow planted to good forage plants. Fertility of the soil should be improved by such practice and animal production increased.

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Efforts to improve the marketing system for cattle have been only partially successful. The establishment of fly-free corridors for trailing cattle to market has not been accomplished, although disease control stations and watering facilities have been established on the routes. Increased use of rail and road transportation has facilitated the movement of cattle, but transit times are long and losses of weight and stock are still excessive. Modern demonstration abbatoirs have been constructed but have not yet been greatly influential. Perhaps least wastage would result if the cattle were slaughtered near the production areas and the carcasses transported to consumption areas. This will require development of refrigerated rail and trucking facilities, refrigerated storage, and, perhaps as important, a change in the consumer who now prefers hot beef.

Milk production for human consumption is not of importance in Nigeria. The Fulani sell some excess milk, and there is a milk drying plant supported largely by surplus from Fulani herds. Some demonstration dairy herds are maintained by agricultural ministries, but there is no economically successful commercial-type dairy in the country. Development of a dairy industry in Nigeria is a long-range possibility. Research and demonstration activities have not yet shown that commercial dairies are technically and economically feasible, and there is at present little demand for dairy products.

Commercial pork production has been reasonably successful in Nigeria, and much effort is being given to encouraging swine growing as a village and farm settlement enterprise. One of the major limitations on swine production as a commercial enterprise is the shortage of concentrate, particularly protein, feeds. Unlike cattle, the pig competes directly with man for food. The major effort to develop pork production thus is placed on feed resources. If pork production is to be economically successful, utilization of by-products of food processing must form the basis of protein nutrition of swine in Nigeria as in other countries. At present little use is made of such by-products, and protein concentrates are either little used or are imported.

Similarly, although important advances are being made in poultry production in Nigeria, the commercial industry is based on imported concentrates. For both swine and poultry production, attention should be given to utilization of by-products of domestic food processing. For example, although the brewing industry is large and growing, no use is made of the valuable brewer's grains in feeding of livestock (except for a minor use by a dairy). The residue from the one large wheat-milling enterprise is exported except for a very small tonnage. Some rice by-product is used, but the rice milling industry is not large or centralized. Most of the groundnut cake produced is exported; little cottonseed is now pressed, but some is fed as whole seed to cattle. Palm kernels are nearly all exported. If the domestic oil-extraction industry is expanded, the palm kernel presscake can supply a good source of protein feed. Many of

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the by-products of meat processing used in other countries for animal feed are not available in Nigeria, but if meat processing becomes centralized, valuable feedstuffs can be salvaged.

An important contribution to improved food supply can be made by utilizing these by-products in place of imports. Research in animal feeding might usefully investigate advantageous use of these materials in conjunction with the local feedstuffs.

The indigenous goat is apparently resistant to trypanosomiasis and could be more intensely exploited as a producer of meat and milk, particularly in the southern areas of Nigeria. Investigation into husbandry and breeding of goats should be encouraged.

Fisheries. Domestic commercial fish production is only about 60,000 long tons. On a short-term basis, this production is likely to be expanded only moderately by establishing fish farms for fresh water fish and by enlarging the inshore fleet of trawlers.

Recent estimates put the Nigerian catch at 15,000 tons from Lake Chad, 15,000 tons from other fresh water sources, 25,000 tons from inshore canoe fishing, 3,500 tons from inshore trawlers, and only a few hundred tons from offshore fishing.

Any large-scale increase will necessitate expansion of the offshore fleet, construction of terminals and of processing plants, and development of a distribution system. Encouraging progress is being made in this area. It is estimated that the Chad fisheries can be expanded, and there is much activity in developing other fresh water fisheries. Some fish-farming projects have been highly successful.

The preservation and distribution of fish from the Chad fisheries to the consuming areas is a wasteful, inefficient process, and research efforts have been devoted to development of effective, economical means of preserving the fish. Since 30-40 percent of the weight of dried fish is still lost to insect damage between the processor and the consumer, it is apparent that the problem has not been solved.

Long-Range Problems and Progress

The population of Nigeria is becoming increasingly urbanized, and as the resources of the country are developed, this trend will be accelerated. To feed a population of this kind requires an agricultural and food industry of vastly different structure than that sufficient for subsistence of a largely rural population. The most important long-range problem as regards food production and availability is thus that of changing the social structure of agriculture to fit the changing structure of the population and economy.

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The technical problems of soil fertility, pest control, food preservation and conservation, animal husbandry, and the like can be overcome, but all this will be of only minor importance if social structure is such that the farmer still tills an acre or two using only the hoe. Indeed, the technical advances are largely lost in a system of this kind.

Much research and demonstration effort is directed to this problem. The farm-settlement programs seek to develop cooperative farming on a scale large enough to be able to profit from technical advances. The plantation-type schemes developed particularly for export crops and to some extent for livestock and food crops are an effort of this kind. The large livestock-range management units, some of the rice-growing enterprises, and the new sugar industry are all examples, but ultimately the change must be made at the tribal and village levels.

The change will require the development of commercial farming and livestock production in place of the present traditional subsistence systems. The difficulties that may be entailed by large and basic social changes are great, and no effort of education, demonstration and assistance should be spared in preparation for the shift.

Food Processing and Technology

Food processing in Nigeria is mainly a village enterprise: the preparation of gari, the smoking of fish, the grinding of grain, the husking of rice, the slaughter and dressing of animals, the pressing of palm oil. In 1962 only 180 food processing plants employing 10 or more persons were in operation: meat processing 9; dairy 7; fruit and vegetable processing 8; grain milling 10; bakeries 41; confectioneries 4; breweries 5; soft drink manufacturers 20; vegetable and animal oil producers 62; miscellaneous 14.

Looking to the future when food processing (aside from the vegetable oil industry) will become an important segment of Nigerian economy, the universities, and to some extent government agencies, are intent upon developing curricula and research facilities in food science and technology. It is important in Nigeria that this development be encouraged. Except for the extraction of oil from groundnuts and palm fruits (and kernels to a small extent) little processing of food materials for export is done. The value that is added by processing can be of much importance to the economy, and the by-products can be useful. Food processing for export--and for domestic consumption when that market develops--that might be encouraged is a matter to be examined. The processing of cocoa is an obvious candidate. It is apparent that citrus production might be developed; also other processed fruits and meat products might find expanded markets. Vegetable production for processing might become a commercial enterprise in a few areas, on the plateau for example. Fish processing both for human and animal consumption will accompany or follow the development of a deep-sea fishing industry. For immediate domestic application, protection of food from insect and other damage in storage needs expanded study.

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In developing their programs in food science and technology, the universities and other research facilities (e.g., the Rockefeller-Ford sponsored agricultural research institute) might well jointly examine the needs in the field and how best they can combine their facilities and talents. Obviously the universities must present the basic curriculum in food science (analytical chemistry, microbiology, human nutrition, food biochemistry) and the applied aspects (food engineering, quality control, management, economics, food law and regulatory control). Laboratory scale research will be part of this curriculum. Developmental and pilot plant research might wisely be shared by the research institute and the universities. The possibility of the institute's cooperating with the university in graduate training should be investigated. Such cooperation might include provision by the institute of pilot plant facilities for and supervision of students doing thesis or other research projects in food engineering, product or process development, and the like. It might also include the use of institute staff as lecturers in university courses.

The beginnings of food science research might well include investigation of nutrient content of indigenous foods and development of food products incorporating features of traditional foods but with enhanced nutritive value. Indeed, important work has already been done in this area. Nicol encouraged the development of Arlac (groundnut flour, skim milk powder, minerals and vitamins), and Bassir and Akinrele have developed a promising soya-gari-supplement mixture. Investigation should be aimed at finding those combinations best suited to Nigerian resources and acceptance.

Regulatory Control of Food

A note on food law and regulation may not be out of place. At present there is little regulation of food trade. Standards of sanitation in markets are not high, meat inspection at slaughter points is prescribed, but the service is understaffed and inspections are not detailed. There are no enforced quality or quantity standards in the markets. Sales are by measure or piece rather than weight, and the measures are not standardized. Much of this is of little consequence in the present stage of development of the food trade. As processing and marketing become more centralized and as the consumer becomes more concerned, enforceable regulations will become necessary.

In developing its food laws and regulations, Nigeria will have the benefit of the codes developed by the Food and Agricultural Organization and World Health Organization as guides. Particularly for its export trade, Nigeria will need to develop its regulations to accord with the proposals of the FAO/WHO Codex Alimentarius. For internal purposes, gradual education for a number of years of producer and consumer through moderate use of regulations might be advocated before stringent punitive regulations are adopted.

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Education

The Federal and Regional Governments well know the importance of education in the development of agriculture and food production. At the university level four faculties in agriculture and one in veterinary medicine are developing. The Regional Governments are all involved in technical training in agriculture at the secondary school level and beyond. The training schemes for livestock and veterinary assistants, and for agricultural advisors and home economics advisors in the extension programs are all evidence.

The needs in adult education are great, and the extension services have a tremendous challenge in all these fields. If the transition from a subsistence, hoe-culture, traditional agriculture to a commercial farming enterprise is successful, the extension education system will be largely responsible.

The present supply of well-trained extension personnel is limited. This is particularly true of extension work with the village women and in the area of food crop production. Consideration should be given, while personnel is so limited, to broadening the scope of the specialists. In particular the home economics agents working for the ministries of agriculture might be given instruction in basic sanitation and maternal and child health by ministries of agriculture might be given instruction in basic sanitation and maternal and child health by ministries of health so that their efforts in the homes can be broader.

Present emphasis in developing the extension services is both on upgrading the competence of the service and increasing staffs. As noted, the most challenging problem of all of agriculture in Nigeria must be a responsibility of the extension services, and both numbers and the highest competence will be needed.

Summary

Food Production. Production of the food staples is adequate or nearly so for the present population and standard of living. Only stockfish and cereal grains are important food imports. Production of animal protein is localized because of environmental conditions and in general is inefficient.

Food Availability. Again the availability of the food staples at reasonable prices seems generally adequate. Uneven distribution of protein-rich foods is evident. Fruits and vegetables are in evidence in markets but some consumption data indicate limited usage by much of the population. A weak point in the supply of food is that of conservation. There is great wastage of grains, legume seeds, and some processed fish caused by insects and other pests.

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Problems. As the country becomes more industrialized and urbanized, the structure of food production will have to change. The traditional structure of agriculture, based as it is on subsistence production, will not suffice. The technical problems are fairly readily soluble as has been demonstrated in experiment stations, demonstrations, and management units.

The problem of protein production, supply and distribution is one of the most serious, particularly the problem of protein of animal origin. The beef production and marketing enterprise eventually must be redirected from the traditional system to one designed to produce food. Progress is being made in poultry production for meat and eggs, and pork production both as a commercial and a household enterprise shows promise. Disease is the greatest deterrent to animal production. Feeds are expensive, but there are unused sources of feedstuffs in the country--brewer's grains, milling offal, oilseed by-products. There is also the possibility of producing fish meal. Problems of range management and forage production and conservation are also being attacked.

The problems of conservation are great. The problems of storage have long received attention in Nigeria but much remains to be done. There is little food preservation except for drying and smoking of beef and fish and the preparation of gari, and storage after treatment is inadequate.

Progress. There is general awareness of the problems associated with providing food for a growing population and one changing in its social structure. Research on the technical problems is going forward. There are research programs in soil-plant relationships, plant and animal breeding, control of plant and animal diseases, feed and forage production, and fisheries development. Demonstration programs are showing that much can be done with the knowledge at hand. Interest in food science and technology is evident. Attempts at changing the social structure of agriculture are less advanced. As the extension services and other educational devices at the farm and village levels become adequately staffed, facilitating this transition will be their greatest challenge.

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V

SURVEY OF NIGERIAN FOOD SAMPLES FOR AFLATOXINS[1/]

Introduction

The problem of food contamination by common molds probably has always existed. Aside from the undesirable taste imparted to foods or the losses through spoilage, such as occurred in the 19th century Irish potato famine, no major threat to health usually was attributed to this phenomenon. For several decades, however, evidence has been accumulating to indicate that growth of many common saprophytic fungi on moistened foods may result in the formation of substances capable of causing illness or death in animals (1).

Prior to 1959 both Russian and American investigators had demonstrated unequivocally that certain common mold isolates from food were responsible for endemic nutritional diseases. In spite of this evidence, little attention was given the matter until a toxic disease epidemic of commercial animals occurred in Britain in 1960 (2). The extensive losses were traced rapidly to imported groundnut meal found to be contaminated with the common soil fungus, Aspergillus flavus. Shortly thereafter the responsible toxic metabolites were isolated (3) and their chemical structures determined (4). The four difurano-coumarin compounds called aflatoxins are now known to be extremely potent hepatotoxins and in some cases are carcinogenic for certain susceptible experimental animals (5,6). They are designated as B_1, B_2, G_1 and G_2 based on their fluorescing colors in ultraviolet light and the respective Rf values on thin-layer chromatograms. The susceptibility of man remains unknown, but there is no reason for assuming that he is resistant to the toxic effects of these substances. A. flavus, a multiple toxin-producing organism, is but one of many toxigenic fungi, some of which are now known to be causative agents in moldy-food diseases of both animals and man (7).

The recognized hazards associated with consumption of aflatoxin-contaminated foods have led to analyses of groundnut products emanating from various exporting countries. Results have indicated the problem is nearly world-wide in scope, including such groundnut-exporting countries as Senegal, Brazil and Nigeria, among others. The implications are both economic and nutritional in Nigeria where groundnuts are a major export crop as well as a source of good protein food for the population. The latter point was emphasized when production of the UNICEF-sponsored protein food preparations in countries such as Nigeria was hampered by aflatoxin adulteration of the groundnut ingredient.

1/ Appreciation is expressed to Dr. A. D. Campbell, Food Contaminants Branch, Division of Food Chemistry, Bureau of Scientific Research, U.S. Food and Drug Administration, who provided valuable information on experience in aflatoxin evaluation and whose personnel performed certain determinations indicated in the text.

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Several different foods may serve as substrates for experimental growth of A. flavus and production of aflatoxin (8). However, the soil contact of root crops, such as groundnuts, makes them much more vulnerable to natural contamination. Presence of the fungus, of course, does not always lead to growth or aflatoxin production. Moreover, not all strains of A. flavus produce the toxin (9).

Few studies apparently have been made on natural aflatoxin contamination levels of other foods. Among the few that have been analyzed is maize (or corn). One recent report from Nigeria indicates high levels of aflatoxin B_1 in a certain lot of this food (10). In the United States, particularly in the southern states, outbreaks of moldy corn disease prior to 1960 among livestock or domestic pets were attributed to contamination by A. flavus, and several samples of incriminated feed later were found to contain aflatoxin. The pathological features of the mycotoxicoses in affected animals, including hepatitis-x of dogs and moldy corn disease of swine and cattle, further suggest aflatoxin as the causative agent in many instances (11, 12).

From the theoretical standpoint foods may become contaminated between maturity and harvest or between harvest and drying as well as during storage and transport. Generally, a moisture content of less than 10 percent does not allow for fungus growth in most foods. However, in the case of groundnuts and several other crops, this limit is exceeded between harvest and complete drying. Ideal conditions may also result from unintended or accidental wetting of the food during storage and transport (13).

The Nigerian Government was prompt in responding to the aflatoxin problem as it related to groundnut crops. Particularly cogent were studies carried out at Mokwa and several other stations in the Northern Region to determine when fungus contamination and growth occurred, what factors favored contamination, and practical control measures that might be considered. These studies, which are still in progress, disclose that most of the contamination and aflatoxin production occur in groundnuts after lifting from the ground. Occasionally, failure to harvest the nuts when fully mature, or plant death before harvest, may result in some contamination below ground. Of greater importance, however, is the method of harvest and drying. Damage to the pods from insect activity or mechanical damage from lifting greatly predisposes the kernels to fungus attack. The method of drying, as one would suppose, is quite important. Here the problem is essentially one of effecting a rapid dehydration to about 8 to 9 percent moisture without such excessive moisture removal as to produce brittle and broken kernels. These very practical field experiments have been detailed by Harkness and MacDonald and their coworkers of the Institute of Agricultural Research, Ahmadu Bello University of Samaru (14, 15).

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Equally important with proper culture of groundnuts is suitable storage. Very little information has been published on this phase of the problem. In Nigeria this aspect of aflatoxin research is the responsibility of the Nigerian Stored Products Research Institute, and relevant data from this source were not obtainable at this time of writing. During his tour of northern Nigeria the author noted the high pyramids of sacked groundnuts in the areas around Zaria and Kano (See figure facing page 1). The time of the survey (February 1965) was the height of the dry season and apparently no protective cover was considered necessary for the pyramids. However, one wonders if the weather is always so predictable as to allow adequate time for cover to be provided in advance of any rainfall. For example just prior to the visit to Zaria and Samaru a brief rain shower had occurred in a nearby local area.

A further measure proven of practical importance in controlling the level of aflatoxin in groundnut meal for the Arlac 1/ program is the use of a better basic grade of groundnuts along with selection aimed at elimination of discolored or defective kernels (16). Studies in the United States and elsewhere have demonstrated the higher incidence and levels of aflatoxin in dark or obviously discolored nuts. Photometric sorting has proved to be an effective method for the elimination of damaged nuts in the United States.

Purpose of the Aflatoxin Analyses

It was believed that analysis of several different foods produced and consumed in Nigeria would provide a valuable indicator of the possible level and frequency of consumption of aflatoxins and give useful experience in designing similar surveys in the future. The purposes of this aflatoxin survey of Nigerian food were as follows:

(a) To obtain an estimate of the extent of food contamination with aflatoxin at the time of sampling,

(b) to determine the approximate intake of aflatoxin by various segments of the population,

(c) to identify foods most frequently containing aflatoxin.

1/ Arlac is the name given the dehydrated food sponsored by UNICEF. It has the following approximate composition in percent: skim milk solids, 23; groundnut flour, 75; minerals and vitamin supplement, 2.

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Types of Food Samples Collected

Most food samples consisted of composites prepared from various cooked dishes described elsewhere in this report. These were usually preserved with 5 to 15 percent oxalic acid and shipped by air to the United States. Approximately 2 to 4 weeks elapsed between collection and receipt, during which time the samples were subjected to ambient temperatures. Upon arrival at the laboratory they were placed under refrigeration (10° C) until the analyses were performed. Limited facilities allowed only a few to be processed each day. The period of cold storage, therefore, varied from 2 to 4 weeks after receipt.

Original plans for aflatoxin analyses called for extraction of the liquid or perishable food samples in Nigeria at the time of collection. However, since adequate laboratory facilities were not available for this purpose, it was necessary to transport the oxalic acid-preserved foods by air to the United States and carry out all procedures there. The effect of the acid on aflatoxin was not known initially, and it was necessary to run simulated food controls with and without added oxalate in order to assess this factor at least qualitatively. Results of this preliminary study indicate some diminution of the fluorescence of aflatoxin B spots on thin-layer chromatograms due to prolonged contact of aflatoxin with oxalic acid. However, the aflatoxin of both samples was readily detectable and recognizable. It was not deemed advisable to attempt precise measurement of this effect in view of the possible protective or buffering effects of the different foods and the varying quantities of oxalate that were used in the different samples. It is evident, however, that oxalic acid preservation tends to be detrimental even though the extent to which this factor may have influenced any negative findings cannot be ascertained.

An additional group of samples consisted of dry foods collected from the markets of various localities, as well as groundnuts served in some of the hotels. No preservative was used for the dry foods.

The author noted the physical condition of food for sale in markets at Ibadan in the Western Region, Kaduna and Kano in the Northern Region, and an Aneng market near Onicha Ngwa in the Eastern Region. Very few obviously molded foods were observed although insect damage was much in evidence. Special samples of moldy animal food were obtained from scientists in the Northern Region.

In addition to foods, three composites of human urine were collected in different villages. About 1 liter of each was preserved at low p_H and transported by air to the United States for aflatoxin analysis.

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Analytical Methods for Aflatoxin

The procedures used for extraction were adapted from various methods used by laboratories in several countries where active aflatoxin research is under way. They are detailed in Appendix 3.

Results and Discussion

The food and urine samples analyzed for aflatoxins are listed in Table 11. Only three of the 79 specimens gave unequivocal evidence for the presence of aflatoxin. Of the three, two were groundnut products and the third was a composite of 27 different food preparations including a small amount of groundnut oil. It is very doubtful that this constituent could be the sole source of aflatoxin contamination. There are two reasons for this conclusion. First, groundnut oil constituted a very small percentage (about 0.1 percent) of the total sample, and secondly, the toxin, although it may be suspended to some extent in oil, is usually inactivated in the refining processes. Rather, the high levels observed suggest that more than one of the food constituents of the composite contained relatively large quantities of aflatoxin.

The total quantity of aflatoxin in groundnuts (C-30) obtained from a hotel at Enugu is very high (10.1 ppm total). These nuts were selected on the basis of their dark appearance. However, dark colored nuts taken from those served at a hotel in Kano contained no detectable aflatoxin, and it is presumed that much of this darkening was due to surface charring in the roasting process. Peers reported finding aflatoxin levels of 6.0 to 7.5 ppm in "initial, hand-picking rejects" from Zaria. Since the rejects represented about 3 percent of the throughput, he estimated these could contribute approximately 0.2 ppm aflatoxin to the total level found in groundnut cake or flour (16).

According to the categories for aflatoxin levels in groundnut meal established initially by the Interdepartmental Working Party on Groundnut Toxicity Research of Great Britain, 0.1 ppm is considered "low," 0.1 to 0.5 ppm is "medium," 0.5 to 2.0 ppm is "high," and greater than 2.0 ppm is "very high." The Brazilian meal responsible for Turkey-x disease in Britain in 1960 was mainly in the range of 2.0 to 5.0 ppm. Using this classification the total aflatoxin (B and G combined) in the Osegere Village composite (C-66) and the Dongwa Ballah groundnut balls (C-15) are both in the "high" range.

A somewhat unexpected result is the absence of aflatoxin from groundnut meal (C-32) obtained from Samaru. This sample came from the feed reservoir of meal which was being used in experimental feeding on cattle and was thought to contain aflatoxin. It appeared to be moldy, presumably having been inoculated with Aspergillus flavus or contaminated with other moldy meal. No prior analytical data were available on this feed.

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TABLE 11 RESULTS OF ANALYSES FOR AFLATOXINS, NIGERIA

Source of Sample	Serial No.	Total Volume or Weight Tested	Aflatoxin
Surulere	C-1	270 ml	negative
4th Battalion, Nigerian Army, Ibadan	C-2	250 ml	negative
NMS, Day 3, Dr. Wilson special sample	C-3	240 ml	negative
Asaba, food composite	C-4	270 ml	negative
1st Battalion, Nigerian Army, food composite	C-5	270 ml	negative
UKWA, Asaba, breadfruit, cooked	C-6	180 ml	negative
NMS, Zaria, food composite	C-7	240 ml	negative
Surulere, #1C	C-8	280 ml	negative
Village, Asaba, food composite	C-10	200 ml	negative
Ogri, Ibusa, Asaba	C-11	190 ml	negative
Osegere village, soup	C-12	150 ml	negative
Nsukka village, food composite	C-13	260 ml	negative
Dongwa Ballah, groundnut balls	C-15	150 ml(60 gm)	positive 0.50 ppm B[1] 0.27 ppm G
NMS, Zaria, food composite		100 gm	negative
Kuru, food composite	C-16	55 ml	negative
Ballah village, yam flour, "amala"	C-17	100 gm	negative
Lagos, uga seed (2, used in soup)	C-18	21.7 gm	negative
Ibadan, egusi	C-19	104.5 gm	negative
Ibadan, maize	C-20	100 gm	negative
Fermented gari (3rd special sample)	C-21	45 gm	negative
Ibadan, large brown nuts	C-22	15.1 gm	negative
Aneng, palm wine (dehydrated residue)	C-23	0.44 gm	negative
Cassava gari (near Aba)	C-24	42.45 gm	negative
Ibadan, fermented locust bean	C-25	8 gm	negative
Zaria, groundnuts (Peers)	C-26	5.1 gm	negative
Kaduna, cow peas	C-29	0.8 gm	negative
Presidential Hotel, Enugu, selected groundnuts	C-30	2.8 gm	positive 4.2 ppm B 5.9 ppm G
Unidentified black-colored food	C-31	26 gm	negative
Mold-contaminated groundnut meal (from Carling, Samaru)	C-32	2.1 gm	negative
Central Hotel, Kano, groundnuts	C-33	2.3 gm	negative
Kaduna, groundnuts, shelled	C-34	5.3 gm	negative
Jos, nunuke (Hausa)	C-35	1.1 gm	negative
Kuru, Jos, acha seed, 71A (seed coat intact)	C-36	1.5 gm	negative
Beans	C-37	0.8 gm	negative

1/ Positive findings reported as aflatoxin B and G, which include B_1 and B_2 and G_1 and G_2, respectively.

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TABLE 11. RESULTS OF ANALYSES FOR AFLATOXINS, NIGERIA (continued)

Source of Sample	Serial No.	Total Volume or Weight Tested	Aflatoxin
Locust bean cake	C-38	1.1 gm	negative
Plateau near Vom and Jos, acha seed, Ndet variety (local name "chun")	C-39	1.4 gm	negative
Ballah, yam flour	C-40	1.3 gm	negative
Palm nut meats (kernels eaten between meals, 10-20/person)	C-41	1.9 gm	negative
Tamba, Jos and Kuru, millet	C-42	1.2 gm	negative
Kuru, gurguzu seed	C-43	0.9 gm	negative
Jos (Kuru), guinea corn	C-44	4.1 gm	negative
Zaria, yam flour	C-45	1.3 gm	negative
Kanua, locust tree seeds	C-46	2.8 gm	negative
Enugu (Army), groundnuts	C-47	1.7 gm	negative
Jos (Kuru), millet	C-48	1.2 gm	negative
Jos, finger millet, "tamba"	C-49	1.2 gm	negative
Jos, dwarf millet, "dauro"	C-50	1.4 gm	negative
Rapop, Jos, locust bean	C-51	2.4 gm	negative
Kuru, dried leaves	C-52	1.2 gm	negative
Gari without oil	C-53	1.2 gm	negative
Iburu (plateau near Vom and Jos), acha seed, var.	C-54	1.5 gm	negative
Gari, no oil	C-55	1.4 gm	negative
NMS, Zaria, egusi and groundnuts (original pink sample)	C-56	60 ml	negative
Epe village, food sample	C-57	72 ml	negative
2nd Battalion, Nigerian Army, Ikeja, meat stew	C-58	75 ml	negative
Ibusha village, food	C-59	75 ml	sample destroyed
2nd Battalion, Nigerian Army, Ikeja, rice supper Mar. 9	C-60	78 ml	negative
Lagos, Surulere, food composite	C-61	80 ml	negative
NMS, Military	C-62	75 ml (82 gm)	negative
2nd Battalion, Nigerian Army, Ikeja, lunch Mar. 9	C-63	78 ml (83 gm)	negative
1st Battalion, Nigerian Army, Enugu	C-64	78 ml	negative
Ogri, Ibusa village, Asaba	C-65	8 ml	negative
Osegere village, composite	C-66	77 ml (82 gm)	positive 0.54 ppm G 0.13 ppm B
Ballah village, food composite	C-67	80 ml (82 gm)	negative
2nd Battalion, Nigerian Army, Ikeja, vegetable soup and meat, supper Mar. 9	C-68	78 ml (81 gm)	negative

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TABLE 11. RESULTS OF ANALYSES FOR AFLATOXINS, NIGERIA (continued)

Source of Sample	Serial No.	Total Volume or Weight Tested	Aflatoxin
A Co. Depot, Nigerian Army, Zaria, food composite	C-69	80 ml (83 gm)	negative
Kuru, food composite	C-70	77 ml (82 gm)	negative
Surulere School, Lagos, rice and water	C-71	76 ml (82 gm)	negative
4th Battalion, Nigerian Army	C-72	75 ml (82 gm)	negative
Nsukka village	C-73	77 ml (82 gm)	negative
L.C.C. School, vegetable stew and meat	C-74	42 ml (43 gm)	negative
Gwate Dawa, Kuru	C-75	57 ml (60 gm)	negative
L.C.C. School, Semolina	C-76	60 ml (61 gm)	negative
Asaba, food sample (duplicate of C-4)	C-77	78 ml (82 gm)	negative
Surelere Demonstration School, fish stew	C-78	14 ml (15 gm)	negative
Kuru village, gauta (similar to small tomato)	C-79	2 ml	negative
Urine composite No. 1	C-80	1,010 ml	negative
Urine composite No. 2	C-81	1,010 ml	negative
Urine composite No. 3	C-82	1,050 ml	negative

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Four additional foods consisting solely of groundnut or containing this product as a principal ingredient (C-26, C-34, C-47 and C-56) were negative for aflatoxin.

Three additional food samples gave questionable qualitative tests for trace amounts of B_1 aflatoxin provided the thin-layer plates were not developed in ethyl ether as a preliminary procedure to later development in methanol-chloroform. Where this preliminary treatment was adhered to, the spots attributable to B_1 were not evident upon methanol-chloroform development. One of these samples (C-24) was submitted to the Food Contaminants Branch, Division of Food Chemistry, Food and Drug Administration, for an independent analysis. Their result, using visual comparison of fluorescence of the unknown with dilute aflatoxin B_1 standard after methanol-chloroform development only, was reported as 0.01 part per million. If one should consider the gari positive for aflatoxin, the two additional foods, C-19, egusi, and C-20, maize, would also have to be adjudged as having approximately the same aflatoxin level. This is a very low quantity of toxin, however, and the final interpretation of its significance is doubtful.

It should be noted that extracts of several different foods contained another unidentified blue fluorescing material visibly indistinguishable from that of aflatoxin B_1 and B_2 except for a slight difference in R_f value when developed in methanol-chloroform. The superimposition of a control solution of aflatoxin B on the application site of such samples revealed the nonidentity of this material with aflatoxin B. Furthermore, development of the samples in ethyl ether caused rapid movement of this spotted substance (along with others having different R_f values in chloroform-methanol) almost to the solvent border. Several blue fluorescing, non-aflatoxin materials are known or have separately been detected by others in extracts of certain plants. These include anthranol, and certain of its derivatives, as well as unidentified extracts from certain seed pits and extracts from vermouth (17). However, crude extracts of aflatoxin almost always contain a variety of minor blue and green fluorescing substances in addition to the recognized major components. Few have been studied, and none has been identified.

The most significant aspect of these results is the negative aflatoxin findings in the wide variety of foods represented by the various samples. Of course, the fact that these foods were obtained during the dry season may have been a critical factor. Therefore, similar studies should be performed at other times of the year and at other sampling locations in order to obtain a more comprehensive picture of possible toxin intake. However, it is also quite possible that contamination of the various foods, other than groundnuts, at any time of year is normally low.

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The total food analyzed represents an infinitely small sample of the total consumed in Nigeria. In view of the wide sources of the samples, had there been a large number of aflatoxin-positive samples, including foods other than groundnuts, this would have been a very significant and disturbing picture. The large quantities of toxin found in some of the groundnut products re-emphasizes the importance of this food in considering the aflatoxin problem and confirms as logical and practical the measures being taken in certain Nigerian programs to eliminate the contaminated kernels which are otherwise disseminated into large quantitites of groundnut meal. Additionally, these studies point to the desirability of continuing efforts directed toward improved harvesting and storage of groundnuts in order to minimize the possibility of mycotoxin contamination. They lead one to suggest the desirability of a continuous, year-around study in order to ascertain the possibility of other foods serving as sources of mycotoxins in the diet, and more quantitatively, to assess the frequency and potential level of intake of aflatoxins by various segments of the population.

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VI

FOOD CONSUMPTION STUDIES

Survey Methods and Procedures

The Nigerian survey dietary team consisted of four nutritionists from the United States and one from Nigeria and 12 Nigerian dietary recorders. In order to obtain as large and representative a population sample as possible for the survey, the dietary personnel were divided into two teams. One team consisted of three nutritionists and 7 dietary recorders and the other of one nutritionist and 5 dietary recorders. Ten of the dietary recorders were men who had been trained under Dr. Isaac Dema, Institute of Child Development, Ibadan. The 2 women dietary recorders were assigned to the survey from the Child Health Center at Surulere, Lagos. Five of the recorders had had previous experience in dietary recording and survey work, and the others were trained on the job in dietary survey methods, recording technics, accurate weighing and in the general procedures necessary for obtaining cooperation and reliable information in the homes.

The dietary surveys conducted by one team included (1) weighing and recording the dietary intakes of 68 selected civilian families by the recipe method, (2) a survey of military installations at three locales, and (3) a dietary study of the Federal Government Pilot Program in School Feeding in the Federal District of Lagos.

Survey locations for the dietary studies were selected in as close proximity as possible to the areas chosen for the clinical survey.

Nine locations were studied, throughout the 4 regions of the country: two villages in the Western Region, three in the Northern Region, one in the Mid-West, and two in the East, and the urban area of Surulere in the Federal District of Lagos.

Contacts were made through Maternal and Child Health Center nurses and other local health personnel in the survey areas. These persons were invaluable in establishing cooperation with village chiefs, local leaders and family heads. Preliminary preparations for the dietary survey had been made by Prof. J. Edozien and Dr. Isaac Dema, who had previously conducted similar surveys in various regions of Nigeria.

Families were chosen from as wide a sample of the population as possible to include variations in occupation, socioeconomic level, tribal or cultural background, size of family, and age composition of family. A total of 68 families was surveyed in the nine locations, giving a total population sample of 444 persons ranging in ages from nine days to 82 years (See Table 12).

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TABLE 12. COMPOSITION OF CIVILIAN SAMPLE IN THREE-DAY DIETARY STUDIES BY LOCATION, NIGERIA

Area Location	(Epe) Epe		(Ibadan) Osegere		(Nsukka) Agbamere		(Ilorin) Ballah		(Jos) Kuru		(Asaba) Asaba-Ibusa		(Lagos) Surulere		Total[1/,2/]	
No. Families	9		10		10		10		7		10		12		68	
No. Persons	69		53		68		65		49		65		75		444	
Age Group (years)	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
<1	2	-	-	2	5	3	1	3	-	1	1	2	5	2	14	13
1-3	2	3	1	2	4	1	2	-	3	1	-	4	3	3	15	14
3-6	3	7	5	-	5	3	4	4	2	4	3	8	6	5	28	31
6-9	3	2	4	2	-	3	5	3	1	3	3	2	8	3	24	18
9-12	4	3	3	1	2	3	3	3	3	2	-	6	2	6	17	24
12-15	-	7	2	1	3	1	1	1	4	1	3	1	-	2	13	14
15-18	1	2	1	1	3	3	1	1	1	1	3	3	1	1	11	12
18-35	4	11	6	8	7	12	5	12	6	8	5	6	11	13	44	70
35-55	5	8	4	5	5	3	6	7	4	3	5	7	3	1	32	34
55-65+	1	1	3	2	1	1	2	1	-	1	2	1	-	-	9	7
Total	25	44	29	24	35	33	30	35	24	25	25	40	39	36	207	237

1/ Children under one year of age are included in this table, but were not counted in the calculations for persons consuming the family food.

2/ The sample includes 27 lactating women and 2 pregnant women.

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The dietary survey began in the Western Region during the second week of February 1965 and continued until the third week of March, terminating in Asaba in the Mid-West. The length of the dietary study period varied from 2 days in one location to 5 days in each of 2 locations.

Civilian Studies

Recipe Method for the Dietary Survey

After initial permission to conduct the study was obtained from the selected families in a given location, the dietary study began in each of the households. The women of each household were told what the study was and how it would be conducted. The nutritionists and dietary recorders established the time of meal preparation in each household (which often was different every day and different for every house in the survey locale). All food for each meal was weighed as purchased, and the edible portion was weighed before cooking, whenever possible. Following preparation and cooking and before consumption, the food was again weighed. Leftover food, both that which was not consumed at the meal and the plate scrapings, were weighed and the weights recorded, the latter being subtracted from the weight of food actually consumed. Food prepared but not consumed at a given meal was usually eaten at the next or subsequent meals, especially in the case of "soup" and "sauce." The quantity of these two items prepared at one time was often planned to feed the family for one, two, or sometimes three days.

In addition to foods prepared in the home, there was considerable consumption of ready-to-eat foods purchased from the local vendors or "buka." Sometimes these foods were consumed by the family at home and sometimes away from the house. In the former case, weighing of the ready prepared product was possible, while in the latter situation dietary personnel had to rely on the "recall" methods by inquiring from the individual the amount of food (i.e., its cost) purchased.

Each day a supply of the numerous ready-prepared foods was purchased by the dietary team from vendors. These foods were weighed so as to recheck family data and they were also used as samples in preparing the food composites. In addition a number of the vendor's products were spot-check weighed in order to determine an average or "standardized" weight of a penny, half-penny or threepence, etc., portion. It was found that the weight of a vendor's penny-portion for a particular item sometimes varied by 50-75 grams.

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Whenever possible and if permission could be obtained, members of the dietary team went to the vendor's home and weighed, before and after preparation, recipe ingredients of foods to be sold as ready-prepared. Weighings were also made of a random number of individually wrapped portions that were to sell for a designated price. In this way, average weights of such a food item and at times also its composition could be obtained.

Village markets in most of rural Nigeria are run in fixed cycles. Market days are held for two or three days in one village, and a day or two in the next, and so on, repeating the cycle through a group of villages. These markets were visited by the dietary team members in order to identify local foods being consumed, to weigh portioned and priced amounts, and to obtain samples for the food composite. The information obtained on price per weighed amount of food item was often used as a cross check on the information obtained from the housewife when items purchased in the market in certain amounts were weighed intact in the home. Table 13 presents lists of the commonly consumed foods that appeared in the markets of villages surveyed and their prices. Markets in urban centers usually presented market prices entirely different from those of the village market for the same food item of the same weight.

Obtaining Foods for Analysis of Composition

Composites of the foods consumed during the survey period were prepared at each location. The food composite contained a 10 percent portion of the average amount of each food consumed per person per day (on a per caput basis). Raw foods for the composite were purchased in local markets or brought from the families surveyed. Samples of cooked foods were obtained from the amount prepared for the family, from local vendors who made and sold ready prepared food items (as described above) or, in some instances, the local women prepared an identical dish for the food composite from ingredients brought to her by the team nutritionists.

Calculations for the amounts of food in the composite were made by estimating the average weight consumed per person per day from the dietary intake of all persons studied during the survey period. The food composite that was prepared for chemical analysis contained food in the "as consumed" form and was not a composite of raw food ingredients before consumption, except when a particular food was consumed in the raw state, e.g., fresh fruit.

Preparation of Food Composite

Samples of individual food items or prepared dishes containing several food items were blended together in proportion to actual consumption. Usually 40% of the daily intake of each food was used for blending because the quantity of food available for samples was limited. Heterogeneous samples were blended individually before the 40 percent portion was measured for routine blending. Water was added at a uniform

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TABLE 13. FOOD PRICES AND AMOUNTS SOLD IN SOME NIGERIAN MARKETS, 1965

Food Item	Weight gm	Price
Market--Osegere		
Dry Gari	1465	6d
Ewedu (with stalks-50% waste from stocks)	220	1d
Cassava Flour (coarse)	1040	3d
Large Snails with Shells	560	1/6d
Spinach (tete)	320	1d
Alapa (beans, melon seed, salt)	75	1d
Eko (tutu)	420	1d
Akara (beans)	70	1d
Amala	315	1d
Ewa	180	1d
Market--Egbede		
Salt	100	1d
Onions	90	1d
Melon Seeds (unshelled)	160	3d
Melon Seeds (shelled)	72	3d
Boiled Cowhide	50	1d
Groundnut (in shells)	12	1d
Stockfish, Dried, Norwegian	100	1d
Coconut	200	1d
Tomatoes, fresh	80	1d
Okra (dry)	70	1d
Okra (fresh)	54	1d

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TABLE 13. FOOD PRICES AND AMOUNTS SOLD IN SOME NIGERIAN MARKETS, 1965 (continued)

Food Item	Weight gm	Price
Market--Egbede		
Bitter leaf	100	1d
Three-leaf Yam (cooked)	480	1d
Plantain (with skin)	710 (2)	1d
Atarado (fresh pepper)	28	1d
Oranges (6)	1160	1d
Bananas (with skin)	1790	3d
Red Palm Oil	600	9d
Beef, fresh	1120	5 shillings
Market--Dugbe		
Dried Red Pepper	10	1d
Canned Tomato Puree	75	5d
Kola Nuts	18	2d
Market--Osegere		
Hot Pap	500	1d
Rice (Jollof)	170	1d
Market--Ballah		
Pounded Yam	980	9d
Locust Bean Cake	7	1d

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ratio within samples during blending to reduce the viscosity and facilitate mixing. After thorough blending of a mixture of the foods representing 40 percent of the average daily intake an amount of the slurry to equal 10 percent of the average daily intake was placed in one sample container containing oxalic acid and another 10 percent sample was placed in another container with alcoholic potassium hydroxide. Additional water was added to standardize size of sample.

The sample containers were labeled and sealed with tape to prevent the loss of fluid in transit or by evaporation. The final food composite samples were shipped to the central laboratory at Ibadan and stored under refrigeration until shipment to the United States at the end of the field study.

Calculation of the Nutrient Composition of the Diet

Calculations for nutrient intake were made on all the food samples, using tables of food composition. The tables used were "Tables of Representative Values of Foods Commonly Used in Tropical Countries," by B. S. Platt (Medical Research Council, Special Report Series No. 302) and "Composition of Foods, Agriculture Handbook No. 8," prepared by the Agricultural Research Service, U.S. Department of Agriculture. For these calculations the food items in each food sample were converted to the raw edible portion state and calculated as such. Therefore, the data presented in the tables include the nutrient composition of the daily diet by chemical analysis and by calculation from standard food tables and represent nutrient composition values for both the raw (E.P.) and the cooked diet in the survey locations.

Discussion of Results

The nutrient composition of the diets studied is presented as calculated from the tables of food composition in Table 26. The nutrient value of these diets as determined by chemical analysis of the food composites is given in Table 24. The results for both the civilian and the military sample studied are discussed on page 85 of this chapter, following the description of the diet studies in the military.

Indicated nutrient intakes as estimated by reference to tables of food composition differed in many instances rather widely from estimates based on analysis of composited food samples. There is no adequate explanation for these differences. They may be due to difficulties in sampling foods or of obtaining representative aliquots from the composites for analysis. Inaccuracies or deficiencies in the tables of food composition used or other unrecognized difficulties may also have contributed to these differences.

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Despite the uncertainties of the information obtained, the dietary information indicates that the iron, phosphorus, vitamin A, niacin, and ascorbic acid needs were being, in general, adequately supplied by the dietaries consumed at the time of the survey. Indicated protein intakes were low for the population groups studied in two locations, Kuro and Asaba. Calcium and thiamine intakes were low in several locations, and riboflavin intake was low in most of the locations.

The probable deficiencies in food composition tables indicated by differences between analytical and estimated nutrient contents of dietaris emphasize the need for a program designed to analyze the foods of Africa systematically for nutrient content. The study should be so designed as to yield data specifically for use in constructing tables of food composition.

Food Consumption Studies in Three Locations

The second dietary team made a separate seven-day food consumption study in each of the three locations of Epe, Zaria (Hunyuki village) and Port Harcourt.

Procedures used in these surveys were similar to those used in the important nutrition survey work carried out in Nigeria by Collis, Dema and their coworkers (See References 12, 13, and 14 in Chapter II). In total, 30 families comprising 185 persons were studied. Results are presented separately in Tables 14 and 15.

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TABLE 14. COMPOSITION OF THE CIVILIAN SAMPLE IN THE SEVEN-DAY DIET STUDY, NIGERIA

Age (years)	0-2		3-5		6-8		9-13		14-21		22+		Total		No.	No.
Sex	M	F	M	F	M	F	M	F	M	F	M	F	M	F	Families	Individuals
No. of individuals tested each location																
Epe	1	-	4	-	3	4	4	7	3	2	6	14	21	27	9	48
Zaria	2	2	5	1	5	-	2	1	1	3	9	15	24	22	8	46
Port Harcourt	8	3	9	7	5	8	7	5	6	7	13	13	48	43	13	91
Totals																
Sex	11	5	18	8	13	12	13	13	10	12	28	42	93	92	30	185
Age	16		26		25		26		22		70		185			

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TABLE 15. SUMMARY OF CALORIE AND PROTEIN VALUES OF EPE, HUNKUYI (ZARIA) AND PORT HARCOURT DIETS, FEBRUARY/MARCH, 1965

	Epe	Hunkuyi (Zaria)	Port Harcourt		
	Farm Families		Operatives (Senior Laborers)	Junior Clerks	Senior Staff
No. of families	9	8	4	7	2
No. of persons	48	46	29	52	10
Food bulk (gm/head/day)	1054	1278	1096	1245	1164
Total calories	1868	1377	1510	2353	1718
Calorie intake as % of requirement	82	63	71	106	87
Crude protein (gm/head/day)	56	39	50	65	74
Protein score (%)	70	69	53	65	87
Reference protein (gm/head/day)	39	27	27	42	64
Protein intake as % of requirement	84	53	49	73	146

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Military Studies

Surveys were made of four military messes in three locations in Nigeria: a cadets mess at the Nigeria Military School in Zaria in Northern Nigeria, a company of trainees also in Zaria, a battalion in Enugu and another at Ibadan. Messing facilities and practices, including ration issues, cooking and food waste, are described below in some detail for the two studies made in Zaria as being generally representative of such procedures in the military. Results of the nutrient intake studies in all 4 messes follow these discussions.

Students' Mess, Nigeria Military School

The Nigeria Military School (N.M.S.) is located at Zaria in northern Nigeria on the grounds of the depot trainee camp. The students' living quarters, classrooms, training compound, medical facility, recreational area and mess halls are located a distance from the remainder of the military installation in close proximity to one another. The student census at the time of the survey was 265. During the week of the survey, however, seventeen students were away at Kaduna taking part in an athletic training program.

The students enter the military as early as 13½ years of age. The adolescent age group must thus be taken into consideration when evaluating nutrient intake and determining the nutritional needs of the cadets. Recommended daily allowances for some nutrients for the Nigerian adolescent have been presented in the Report of the Health Education Seminar, Ahmadu Bello University, Zaria, April 1964, and are listed in Appendix 16.

The nutrition survey of the N.M.S. was carried out by one member of the dietary survey team assisted by 3 dietary recorders. The survey period began with the noon meal on Tuesday, February 23, and ended with breakfast Friday, February 26.

N.M.S. Dining Facility

The school has two mess halls, one for the junior cadets and the other for the seniors, serving approximately equal numbers of students. The mess halls are located on either side of the mess kitchen, to which they are connected by small open roof passageways. The mess halls are long buildings with a door at each end. They are equipped with tables and benches along each wall, with a wide area in the center for traffic. Each table can accommodate approximately 8 cadets. Each student brings his dishes and flatware (plate or bowl, cup, knife, fork and spoon) to the mess hall at meal time. After the meal is over dishes are washed at a tap in the yard adjacent to the mess kitchen, and returned to the barracks. The schedule for the meals served in the mess hall is as follows: Breakfast is served at 8:00 a.m., the mid-day meal is taken at 2:00 p.m. and the evening meal at 6:30 p.m.

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Foods Eaten Outside the Mess

Cadets are provided a bimonthly allowance. There is a canteen on the post where sundries can be purchased. Furthermore, local purveyors are permitted on the grounds to sell ready-to-eat foods. In these ways students are able to supplement their daily intake with food other than that received at meal time. During one of the survey days students were issued their allowance and the decrease in the number present at the evening meal was attributed to this fact. Students are given leaves to go into the nearby town (Zaria) where they can also acquire food. The survey did not attempt to include food eaten other than that served at meal time in the mess hall.

Student Regulation Ration

The ration or menu for the military cadets was planned taking into consideration several factors. First, cadets are selected from all regions of Nigeria and from the various national tribes and cultures. Because the diet varies greatly among these groups, the menu is planned to have some flexibility and appeal to all. Second, the ration issue is limited to some extent by the available food supply in the locale, seasonal factors and the cost of the various food items in the area. Also, substitutions or eliminations may be necessary at times. For example, oranges, bananas and other local native fruits are included in the student ration during the season of greatest available supply. However, at the time of the survey the dry season was well under way in northern Nigeria, and bananas were selling in the Zaria markets for one penny each. When in season a large hand of bananas could be purchased for this price. Needless to say neither bananas nor other fruits were listed on the weekly ration at this time. Two other food items that are important in the preparation of Nigerian dishes yet subject to seasonal availability and fluctuating prices are fresh peppers and dried chilli peppers. The latter appeared only once in the ration issue during the survey visit.

The menu is determined from the regulation ration and is planned for a week. The menu for breakfast includes a carbohydrate food such as boiled white yam, or baker's bread made from local Nigerian flour, the latter being served twice weekly. At the noon and evening meals two common carbohydrate staples are served, teba (made from gari, cassava which is first fermented and then dried) and rice. At all three meals a soup of vegetable and meat or vegetable and dried fish is served. Coffee with canned evaporated milk and sugar is served at the morning and evening meal. The current weekly menu recorded the following staple items offered alternately:

	Breakfast	Lunch	Dinner
Monday	Bread	Teba	Rice
Tuesday	Beans	Rice	Teba
Wednesday	Yams	Teba	Rice
Thursday	Bread	Teba	Rice
Friday	Yams	Teba	Rice
Saturday	Beans	Rice	Teba
Sunday	Yams	Rice	Teba

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The cadet ration is issued from the military headquarters in Lagos. The following figures were provided by the Commanding Officer at Zaria as the current daily issue in approximate amounts for the N.M.S. However, as seen in Table 16, the survey observations indicate there is some difference between the amounts to be issued by regulation and the amounts actually issued. There is loss through waste in preparation of some ration items which thereby decreases the amount of the ration considerably from the regulation. Table 16 presents the differences in amount of current ration items. Table 17 presents the daily ration items and the actual amount of each received per day by each cadet during the 3-day study period. The E.P. weights of the ration items were calculated from yield studies completed on food items during the survey (described later). The total amount of each ration item is determined by the daily student census which is fairly constant. However, if there is a decrease in the census of any significance due to field maneuvers, off-camp training, etc., the amounts issued are correspondingly decreased.

Ration Issue and Menu Items

A noncommissioned officer from the N.M.S. mess is responsible for obtaining the daily rations issued from the central stores. The daily rations are issued to N.M.S. each morning and transported from the central stores to the N.M.S. mess kitchen in a military van.

During the survey a visit was made to the central stores to observe the issuing procedures, the handling of food items, storage facilities, to discuss purchasing procedures and policies with the Commanding Officer (C.O.) in charge of central stores, and to obtain information concerning the N.M.S. ration provision.

At the central stores the rations issued are weighed and checked by the sergeant before they are released. Several mess kitchens on this base receive their food supply from the one central store facility. This daily weighing and checking is carried on in a well-ordered routine.

It was noted that some of the sacks of cereals were broken, resulting in loss of the food item. Refrigeration was maintained for items such as meat and fresh produce. The stores unit for the most part was clean and well kept.

The mess ration C.O. informed team members that the food is supplied by a contractor on a 6-month basis. Contracts for the food supplies are bid upon by food purveyors. The decision as to who is to be awarded a contract is made in the military headquarters in Lagos.

The ration allowance for the Zaria depot is budgeted at approximately 2 shillings and 10 pence per capita per day. For bush exercise the allowance is increased to 3 shillings and 6 pence per man per day. For some camp maneuvers a food-pack ration is used, but for bush exercises the food contractor is responsible for transporting the food to the field site where it is prepared and cooked.

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TABLE 16. COMPARISON OF REGULATION DAILY RATION ISSUE WITH ACTUAL RATION ISSUE, A.P. VERSUS E.P. WEIGHT, NIGERIA MILITARY SCHOOL, 1965

Ration Items	Daily Amount to be Issued by Regulation (lbs A.P.)	Actual Amount Issued (Average for 3 days) (lbs A.P.)	Actual Amount of Usable Weight Per Ration Item (lbs E.P.)
Rice, upolished, Jebba	183	127.0 lbs	127.0 lbs
Yams, white	183	513.8 lbs	461.8 1/ lbs
Gari (cassava)	183	114.8 lbs	114.8 lbs
Dried fish	61	30.0 lbs	15.5 2/ lbs
Meat, fresh (beef)	152	141.0 lbs	114.0 3/ lbs
Beans, dried	30	None issued	None issued
Melon seed, egusi	15	15.0 lbs	15.0 lbs
Groundnuts	21	21.0 lbs	21.0 lbs
Milk, canned, evaporated	15(40-6 oz tins)	15.0 lbs	15.0 lbs
Sugar, white	19	19.0 lbs	19.0 lbs
Tomatoes, fresh	61	13.0 lbs	13.0 lbs
Onions	61	10.6 lbs	10.6 lbs
Leafy green vegetables, fresh	61	23.5 lbs	16.0 4/ lbs
Bread	14 bi-weekly	155.9 lbs	155.9 lbs
Red Palm Oil	--	29 lbs	29 lbs

1/ Refuse from yam skins etc. constitute a yield loss of 10%.
2/ Yield loss of 50% in dried fish is derived from bones, heads and wooden skewers placed in the fish.
3/ Yield loss of 10% in the fresh beef resulted from bone that was removed.
4/ A 33% loss in the yield of the leafy green vegetables (aliefu, gbure) was result of discard of the coarse stems and roots from one of the vegetables and from inferior quality in some issues.

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TABLE 17. DAILY RATION ISSUE, TOTAL AMOUNTS AND PER MAN AMOUNTS,[1/] NIGERIA MILITARY SCHOOL, NORTHERN NIGERIA, 1965

RATION ITEM	TOTAL AMOUNT ISSUED PER DAY (lbs) E.P.	AMOUNT ISSUED PER CADET PER DAY (gms) E.P.
Rice, unpolished, Jebba	127 lbs	217.38 gm
Yams, white	461.8 lbs	790.46 gm
Gari (cassava, dry)	114.8 lbs	196.5 gm
Dry Fish	15.5 lbs	26.53 gm
Meat, fresh (beef)	114 lbs	195.1 gm
Melon seeds (egusi)	15.0 lbs	25.68 gm
Milk, canned evaporated	30.0 lbs	51.35 gm
Sugar, white	19 lbs	32.52 gm
Onions	10.6 lbs	18.14 gm
Tomatoes, fresh	13.0 lbs	22.25 gm
Leafy green vegetable	16.0 lbs	27.38 gm
Bread	155.9 lbs	88.9 gm
Groundnuts, E.P.	21.0 lbs	35.84 gm
Red Palm Oil	29.0 lbs	49.63 gm

1/ Raw basis.

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Except for meat no rations are issued on Sundays. This necessitates issuing of a double ration on Saturday to cover both days.

If the mess corporal decides that the day's ration allowance does not need to be prepared, he may retain a portion of the allowance in the mess kitchen storeroom for use at another time. Dried beans are issued in amounts that are not sufficient to feed the cadets for one meal. Therefore, the ration issues are accumulated until there are enough beans to serve everyone for one meal per week (approximately 150 lbs).

Bread made by a local baker from unenriched Nigerian wheat flour is served twice weekly at breakfast. The N.M.S. is the only military unit receiving canned milk. The milk is evaporated, imported from Holland. It is added to the coffee which is served at breakfast and the evening meal. Approximately 40 six-ounce cans are used for each of the two meals, thus contributing a substantial amount of calcium and riboflavin to the diet of these adolescents.

As indicated above, seasonal changes affect the available food supply both quantitatively and qualitatively. August and September are months of scarcity, particularly for leafy green vegetables and yams. Mangoes, a fruit abundantly available in season beginning in April, are supplied by the contractor to N.M.S. Fresh chillies are used in season, as they are cheap in comparison to dried chillies.

The rice in the cadet ration is unpolished Nigerian rice, the source of supply being the Plateau area, around Jebba, and farther south.

While the issue of leafy green vegetables does not meet the recommended ration allowance at all times, an attempt is made to include some leafy greens daily. The two being issued at the time of the survey were gbure (Talenium triangulare) and aliefo or efo (Celosia argentea).

Fresh meat is available in greater abundance in the northern regions than in the south, and for this reason the N.M.S. is able to provide substantial protein of high quality in the daily diet. Dried fish also included in the daily ration provides another dietary source of protein. Groundnuts are added to the soup daily together with egusi (melon seeds) in a substantial amount as a pounded meal, providing additional protein and other nutrients.

Sugar and sugar cane (the latter referred to as "fruit" by the mess corporal) are included in the ration allowance for their caloric value. Approximately 32 grams of sugar are provided for each cadet daily. This is added to the morning and evening coffee.

Kitchen and Mess Facilities

The two mess buildings are located near the edge of the cadet compound adjacent to one another. One includes the junior cadet dining room

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and 2 storage rooms; the other contains the seniors' dining room, the kitchen areas for prepreparation and production, a washing area, and a storeroom.

The mess kitchen proper is composed of three interconnecting rooms. The prepreparation area contains a single sink with drain area, two large work tables, and a rack for storage of utensils. In this room fresh produce is received, sorted, washed, trimmed, and prepared for cooking. Meat is received and cut here. All the meat from Central Stores is in large pieces containing the bone. It is cut into individual portion sizes using cleavers and large knives and then divided into equal portions for supper and breakfast. Meat is used in the soups for the evening and breakfast meals. While the soup is made separately for each meal and at different times, the meat is cut and trimmed at one time, shortly after it is received in the morning. Dried fish is also prepared for cooking here.

Another small room adjacent to the main cooking area is equipped with a sink and used for washing food when necessary and for pot and pan washing. Also located in this room is a gas-fired covered kettle of approximately 50-gallon capacity, used to boil water (for teba) and to cook rice and beans.

The kitchen cooking area is too small for the size of the feeding operation. Most of the cooking is done on three double-burners fired by gas. These are set into a cement frame resembling any large stove. When a meal is being cooked, all burners are usually used. The stove area is used for cooking the soups and for boiling yams. There are no tables or work surfaces in the stove area, but a ledge along the front of the stoves at knee height is convenient for setting cooking pots on.

The cooking pots used in the kitchen for boiling yams, soup, etc., are large, heavy-duty stainless steel, oval- and round-shaped pots with lids. They tare between 11 and 15 kilograms each when empty, and their capacity is approximately 10-15 gallons. Eight such kettles were in current use. For mixing items in quantity, i.e. teba, large covered metal containers resembling a metal storage bin are used. These tare at approximately 10 kg and have a capacity of about 60 gallons. The latter containers are also used for making coffee.

Ladles and spoons of various sizes were available but in short supply. These are used both in the kitchen and on the serving line. A large wooden mortar and pestle was also on hand.

The cooking containers are hand-carried from the mess kitchen to the serving area in the mess hall, and food is apportioned directly from them.

The 3 storage rooms were clean and well kept. It was observed that a very small inventory is kept on hand in the storerooms, as would be anticipated with a daily ration issue.

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There are no refrigeration facilities in the kitchen area. Therefore, items such as fresh meat and fresh produce remain at room temperature from the time of receipt in mid-morning until they are utilized, which is sometimes late in the afternoon. Wilting of leafy green vegetables would be expected, which affects nutrient content. Similarly, fresh meat would be subject to spoilage, and might attract flies, etc.

Sanitation in the Mess Kitchen

Running water is located in the two prepreparation rooms of the kitchen unit but not in the kitchen proper.

Work surfaces are cleaned after use by flushing with cold tap water and wiping. An excelsior-like material grown throughout Nigeria is used nationally as a "sponge" for wiping and washing. The military also uses it for cleaning. No soap or cleaning powders were used for kitchen washup procedures.

Pots, pans, and utensils were washed in the sink areas, and for this a soap powder was used. Floor areas were washed with tap water and a straw broom following each meal period. All the floor areas were cement.

Garbage and waste were disposed of in incinerators.

Mess Kitchen Personnel

The feeding operation and kitchen supervision were the responsibility of a corporal from the battalion. He did not participate in the actual meal preparation, cooking, and serving duties, but he did supervise the acquisition of the daily ration issue at the Central Stores, the kitchen personnel, the food production, and sometimes the meal service in the dining rooms.

The kitchen generally seemed to be staffed by three military personnel from the battalion, although the number was difficult to assess, since various military personnel appeared from time to time for brief periods of kitchen duty. It also appeared that the three military men assigned to kitchen duty were not necessarily the same persons each day. Probably not all those assigned were trained in cookery or food preparation, either in quantity cooking or at the domestic level. Actual food preparation practices received little attention from the supervising officer.

Food Preparation at the N.M.S. Mess

With the exception of cereals, dried pulses, sugar, and canned milk, food received from the Central Stores required considerable preparation before it reached the cooking pot or the mess hall table.

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In Nigeria the most popular ways of preparing foods are either boiled or fried, and this applies, as would be expected, to the military menu. Items served to cadets should be readily identifiable with dishes common to the various cultural groups in the country. Meat and fish are usually cut into bite-size pieces and stewed or fried, or prepared as soup or sauce with condiments and other items added such as fresh or dried chillies, onion, melon seeds, palm or groundnut oil, fresh tomatoes, or canned tomato puree. Vegetables may be included in the meat or fish soup, or a separate sauce or soup may be prepared from the vegetables.

In the N.M.S., mess preparation combined meat and vegetables and fish and vegetables for the soup recipe. Water was added in the initial preparation of the soup. If the amount of soup appeared insufficient when cooking was complete, more water was added to stretch it. Melon seeds and groundnut were pounded separately to a fine meal in a large wooden mortar and then combined for use in soups. This was done daily by one of the mess employees and required a considerable amount of time.

The method of preparation of the fish or meat soup with the yields of some of the food items is as follows: Meat arrived from Central Stores in large pieces (3--4 lb) including the bone or shank. Dried fish was delivered with heads intact. The meat was cut into individual portion sizes and the bone removed. The heads of the fish were removed and the fish was cooked in hot water to remove the bones. The following recipe yield figures for meat were calculated from weight studies done during the three-day survey:

Day #1) Meat, raw (A.P.) = 34.2 kg
Weight of bones from meat = 7.9 kg
% loss from bone = 23.5%

Day #2) Meat raw (A.P.) = 32.6 kg
Weight of bone = 7.0 kg
% loss from bone = 21%

Day #3) Meat raw (A.P.) = 42.4 kg
Weight of bone = 6.7 kg
% loss from bone = 16.6%

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The following yield calculation was completed on dried fish used on the menu over the 3-day period:

Day #1) Dried fish (A.P.) weight = 11.2 kg
Dried fish (E.P.) weight = 4.1 kg
Weight of refuse (bones, heads) = 7.1 kg
% waste loss from refuse = 63.6%

Day #2) Dried fish (A.P.) weight = 14.9 kg
Dried fish (E.P.) weight = 8.7 kg
Weight of refuse = 6.2 kg
% waste loss from refuse = 40%

Day #3) Dried fish (A.P.) weight = 14.2 kg
Dried fish (E.P.) weight = 8.7 kg
Weight of refuse = 6.0 kg
% waste loss from refuse = 42%

Because the fish soup was to be served at the noon meal, preparation began as soon as the items reached the kitchen. The filleted fish, cut-up tomatoes, and pounded onions were placed in one of the large cooking kettles. Approximately 60 kg of water was added, and the kettle was placed on the gas burner for cooking. After the soup had reached the boiling point, palm oil and the groundnut-melon seed meal were added. The soup was cooked for approximately 1 1/2 hours.

Since meat soup is served at both the evening meal and at breakfast, any leftover soup from supper may be added to the soup being prepared for breakfast. The meat used is a less tender cut and requires considerable cooking, so it is placed on the fire before the noon meal has been served and boiled in water until tender (approximately 2 to 3 hours). Near the end of this time the other ingredients are added to the meat and broth. These include pounded onions and chillies (if available), fresh tomatoes cut in small pieces, groundnut-melon seed meal, palm oil, and additional water as needed. The amount of soup prepared is gauged by the capacity of the kettle. If the amount in the kettle does not appear to be enough, water is added.

A green vegetable is included in both the fish soup and the meat soup. During the study these were gbure and aliefo, leafy green spinach-like vegetables which differ in their usable yield. In the case of aliefo, the root and a portion of the coarse stem is removed before using. This results in a poor yield from A.P. to E.P. weight, especially when the root is included in the purchase weight. Most of the gbure is used, and the yield of usable weight is almost 100 percent. In the absence of refrigerators, usable yield may be expected to decrease from wilting and de-

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terioration. One morning during the study, 50 percent of the weight of the gbure was discarded due to deterioration of quality. Such a decrement in yield results in a corresponding increment in cost. The following yield study reports the usable weight and the percent waste loss in green vegetables for a two-day period:

Aliefo and gbure (A.P.) weight = 10.7 kg
Aleifo and gbure (E.P.) weight = 7.3 kg
Weight loss as waste = 3.4 kg
% loss from waste = 31.7%

Following trimming, the vegetable is sorted and then washed. Washing includes soaking for a period of time in hot water. The latter probably is considered a sanitation procedure. This decreases the vitamin content of the vegetable. The green vegetables were added to the fish soup or meat soup during the latter part of cooking. They appeared to be cooked for one hour and at times even more. The nutritive content retained by the vegetable under such cooking is questionable. This is unfortunate, since these vegetables could be a significant source of vitamin C and riboflavin. Over the three-day period of the survey, the amount of leafy green vegetable added to the soup daily for the three meals amounted to 7.3 kg or 16 lbs (E.P.). Therefore, the amount available to each student each day was approximately 27 gm E.P.

Yams were a staple of the cadet daily diet, being given the same preference as they have among the civilian population. White yam, the most common indigenous variety, was used at the N.M.S. mess. Yams were boiled and served at breakfast. To eliminate further mess preparation, they were served cold in the skins, and the cadets were responsible for peeling them before eating. In no instance did anyone consume the skin. As a considerable amount of yams was served at breakfast (average 500 lbs), the cooking process was begun late in the evening. The remainder was cooked prior to breakfast, beginning about 5:00 a.m. This staggered cooking was necessitated by the limited cooking facility. The boiled yams resemble boiled potatoes and are eaten along with the meat soup. Boiled yams were served on two out of three mornings during the survey. The following yield study was made on yams:

Day #1) Raw yams (A.P.) (including skins) = 214.4 kg
Weight of boiled yams (including skins) = 199.7 kg
Weight loss due to cooking = 14.7 kg
% loss due to cooking = 7%
Weight of skins (waste) = 47.6 kg
% loss due to waste= 22.4%

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Day #2) Raw yams (A.P.) (including skins) = 221.1 kg
Weight of boiled yams (including skins) = 208.8 kg
Weight loss due to cooking = 12.3 kg
% loss due to cooking = 5.4%
Weight of skins = 57.9 kg
% loss due to waste = 26.2%

From these figures it is evident that a considerable percent of the purchased weight is discarded in the skins, approximately a 24 percent average for the two-day period. When the cadets peeled their cooked yams, the peelings were thick and considerably more was wasted than necessary. This loss could be reduced considerably if the cadets were aware of this waste and instructed to reduce it.

Yams in season are abundant and cheap, but like most crops, there is a season of scarcity. Some loss is to be expected from yam peelings which is greater than that from boiled potatoes, because yam skins are thicker than those of potatoes; yet it seems that a 24% waste from skins is in excess. It might be mentioned that boiling yams is the most economical and efficient method from the standpoint of mess preparation and personnel involved.

The other two carbohydrate foods in the cadet menu were boiled rice and teba. Teba (the Hausa term for eba) is prepared from gari which is a cassava product. Rice used at the N.M.S. mess was milled but unpolished and was light brown in color. It was a favored menu item of the cadets just as it was among the children studied in the school feeding program in Lagos.

Teba (gari) was served at the noon meal and was prepared simply by adding gari to boiling water. The gari was added gradually to the water and the mixture was stirred to smoothness with a heavy wooden paddle so as to reduce lumping. The average weight of gari used per meal for the 265 cadets for the three-day survey was 51 kg or 112.2 lbs. The amount of dry gari consumed per student per day was approximately 256.5 gm. The gari was combined with water in an average ratio of 2 parts of water to one of gari to achieve the desired consistency. It resembles thick, cooked cream of wheat when served.

The teba was prepared in the tall metal storage bins described earlier. The deep containers permitted the necessary mixing without spilling or wasting the contents. Teba is prepared a short time before mealtime and served at room temperature. Cadets eat teba with their hands, rolling it into mouth-size balls and dipping it into the soup served with it.

Rice is boiled in the large, gas-fired kettle. No preliminary preparation of rice occurs. It is added to boiling water and cooked for

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45--60 minutes, then transferred to large pots for service. Rice is served at the evening meal, and the average amount of raw rice cooked during the three-day period was 57 kg or 125.4 lbs. The average amount of rice consumed per student was 212.4 gm (dry weight). The three-day average of the weight of the rice after cooking was 166 kg or 365.2 lbs. The average daily intake of cooked rice per student was 650 gm, a figure in accord with the random student portions weighed in the mess hall, which averaged 600--750 gm per serving. (The rice after cooking was three times its precooked weight. This is normal for rice cookery.) Rice is served with meat soup, and the students prefer the soup to be ladled over the rice.

The locally made bread (see above) is served to the students for breakfast two mornings per week. It was served on one of the survey days. It was evident that it is very popular with the cadets. Of the 70.9 kg of bread issued for the meal, almost every morsel was consumed. There was little plate waste except for a very small amount of crust. Each student received approximately 265 gm of bread. The bread was consumed with the meat soup, dipped in the soup, or moistened in the coffee. The bread is delivered from Central Stores in loaves weighing approximately 2 lbs each, and cut into one-serving portions on the morning of service.

Coffee is also very popular with the cadets. None is left over. Coffee is prepared by adding boiling water to the Nigerian-grown ground coffee. Canned evaporated milk and sugar are added prior to serving. Approximately 7200 gm of canned milk are added to the coffee made for one meal, or 27 gm per student. As coffee is served at 2 meals each day, this provides 54 gm of evaporated milk per student per day and is the only milk that the cadet receives. Approximately 5.0 kg of sugar are added per batch of coffee per meal. Thus each cadet receives approximately 32 gm of granulated sugar per day in his ration. The coffee tended to be very sweet. Team members were informed that this is the way it is preferred throughout the country.

Refined red palm oil is used in soup preparation. The oil is issued in ready-to-use form and is added to the soup during cooking. The amount consumed per student per day averaged 49.0 gm for the three-day period. This amount of red palm oil according to Platt could provide anywhere from 500 to 50,000 I.U. of vitamin A per day. Even taking this wide range of availability into consideration, this item contributes considerable vitamin A to the diet and may be the only source at times.

Tomatoes are important ingredients of the meat or fish soup. Fresh tomatoes are subject to fluctuation in availability due to crop yield and season and therefore are not a constant diet item. When fresh tomatoes are not available, canned tomato puree is substituted in soup. The entire

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fresh tomato is used with no loss from discarded portions. This particular item is subject to deterioration of quality due to poor handling and storage conditions. The yield loss in this item can often be high.

Onions (usually red) are equally important ingredients for soup. The waste from onions is equally negligible and was not considered significant enough for yield studies. The onions are usually prepared for the soup by grinding in the mortar. The mess was equipped with a small, hand operated grinder for this operation, because the amounts used are much greater than those used at the domestic level.

If fresh or dried chillies are used (Capsicum annum or C. frutescans), they are combined with onion and the two are ground together. During the survey, chillies or fresh peppers were not available to the N.M.S. ration.

Preparation and Plate Waste

Careful observations were made of waste in all areas during the three-day survey period. Due to efficient methods, very little waste occurs in food preparation. Waste and loss are most significant in the goods received from Central Stores. Therefore, purchasing and receiving at Central Stores are the aspects of food service where evaluation of the wastage problem should be made and corrective measures applied. The yield studies in this report show high waste loss occurring in the meat and dried fish and at times in the fresh produce, especially leafy green vegetables. While most of the control is inherent in the specifications for the purchased items as they are ordered from the contractors, there is some degree of loss due to poor handling and storage facilities for the goods after they are received. Fresh fruits and vegetables should be received fresh from the purveyor and as close to actual using time as possible. One- or two-day old vegetables should not be accepted when delivered to the Central Stores. Meat with a high percentage of bone should not be accepted if specifications for the ratio of usable meat to bone are included in the contract. The same criteria apply to fish. Roots should not be included in the purchase weight or price of delivered vegetables, and if they are, adjustment for accompanying loss should be made in the price of the item. The nutritional value of the diet begins with the quality of the food items received at the Stores. If a certain price is being paid for "edible meat", then edible meat should be provided by the contractor.

Waste due to leftover food is evaluated from plate waste left by each individual after he has finished the meal and from food that is left when everyone has been served the amount he desires. This is considered "food not consumed."

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For some items such as rice and bread, the total amount prepared was served. Soup left over from what had been prepared was simply added to the soup pot for the next meal, fish soup left at noon being added to meat soup for supper, and meat soup from supper being added to the meat soup being prepared for breakfast next morning. Because no refrigeration facilities exist in the mess kitchen, attention should be given to the use of leftover items from the evening meal for breakfast the next day, even though the leftover is heated to the boiling point. Throughout the country, cooked dishes, due to the use of fermented ingredients in their preparation, soured rapidly in the warm air temperature.

The amounts of food left over after service might be considered due to overproduction for a given meal. This can be controlled by knowing changes in census count in advance of meal preparation and by using strict weight and measuring procedures in food preparation through use of recipes or formulas. However, plate waste is under individual control for which there is little or no justification, and unless the amounts served are too large, there should be no plate waste. While personal preference and the quality of the prepared food should be considered in evaluating plate waste, it appears that the mess at N.M.S. gives little attention to the latter when feeding the cadets. Good food is usually rejected by no one. Plate waste appears to be highest for the carbohydrate foods, rice, teba, and yam, where the plate waste varied from 35 to 60 lbs for these menu items. In the case of teba, the poor quality of the product served was probably significant in this waste. While the other two products are popular, it is felt that plate waste was largely due to the large amount served to each cadet. Plate waste was 15 percent for rice, approximately 10 percent for teba, and 16 percent for yam.

Results of the Study

Nutrients available per man per day from the ration issue as calculated using food table values are presented in Table 18. The nutrients determined by chemical analysis of a composite sample of the foods eaten are given in Table 24. Results of this study are discussed along with those of the other military locations at the end of the presentation on the military.

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TABLE 18. CALCULATED NUTRIENT INTAKE PER CADET PER DAY FROM THE DAILY RATION ISSUE,[1/] NIGERIA MILITARY SCHOOL, ZARIA

Ration Item	Daily Amount Issued per Man (gms)	Protein gm	Fat gm	Carbo-hydrate gm	Calcium mg	Iron mg	Thia-mine mg	Ribo-flavin mg	Niacin mg	Vitamin A I.U.	Vitamin C mg
Rice, polished	217.38	14.9	9.0	177	53.0	1.76	.154	.06	3.5	---	---
Yams, white, E.P.	790.46	16.0	1.6	192	80.0	9.60	.80	.24	3.2	160.0	80.0
Gari (cassava)	196.5	3.0	---	16.8	110.0	4.0	.08	.08	1.6	---	---
Dry Fish, E.P.	26.53	17.0	1.70	---	870.0	2.3	.027	.054	1.62	---	---
Meat, fresh (beef) E.P.	195.1	36.1	26.6	---	19.0	5.70	.19	.38	9.5	---	---
Red Palm Oil	49.63	---	50	---	---	---	---	---	---	5400	---
Melon Seed, egusi	25.68	6.5	11.7	4.9	13.0	2.08	.026	.0390	3.90	---	---
Milk, canned, evap-orated	51.35	3.5	4.0	4.9	126.0	.05	.02	.17	1.0	160.0	.50
Sugar, white	32.5	---	---	33.0	---	---	---	---	---	---	---
Onions	18.14	.27	---	2.0	5.40	.09	.072	.036	.054	---	1.8
Tomatoes, fresh	22.25	.22	---	.88	1.10	.08	.013	.009	.154	55.0	---
Leafy greens	27.38	.54	.08	1.08	21.6	6.75	.022	.054	.35	270	14.0
Bread, white	88.9	8.0	3.0	45.5	75.0	6.0	.06	.08	1.0	---	---
Groundnuts, E.P.	35.94	9.7	16.2	6.1	18.0	.90	.324	.540	6.12	---	---
Total		115.7	124.0	484.2	1400.	39.3	1.81	1.74	28.2	6045	96.0

1/ Raw basis.

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Study of the Military Mess of Company A, Zaria, Northern Nigeria

One of the northern installations for the Nigerian Military Forces is a depot trainee camp at Zaria in Northern Nigeria, which is based at the same location as the Nigerian Military School (see above).

A survey was made of one of the two company messes for three days beginning with the noon meal and ending at breakfast. One U.S. nutritionist accompanied by two dietary recorders carried out the mess study. The company studied consisted of some 235 trainees. The average age of the men was nineteen years. The greater number were unmarried. Married personnel lived in family housing provided on the base.

Purpose of the Survey

The purpose of the survey was 1) to observe messing facilities, 2) to observe food issuing and ordering procedures, 3) to evaluate food preparation and handling methods, 4) to study cooking and food service procedures, and 5) to survey amounts of food issued, prepared, consumed, and wasted over the 3-day period.

Meal Schedule

Three meals are taken each day by the company troops: breakfast, a midday meal, and an evening meal. The study did not include food items consumed outside of meals taken at the mess. Thus, married troops eating at home have been omitted.

Regulation Ration

Rations are issued daily on the compound, based on the daily troop census. The budgetary ration allowance of two shillings, tenpence per man per day established by the British has remained unchanged. This allowance indirectly becomes the guide for daily issue of food items and amounts.

Average Daily Ration Issue Per Man

Meat, fresh beef (bone in)	10 oz - 280 gm
Dried fish	4 oz - 113 gm
Rice, Nigerian, undermilled	12 oz - 340 gm
Gari (for eba)	12 oz - 340 gm
*Yam	12 oz - 340 gm
Vegetables: leafy green) tomatoes) onions)	4 oz - 113 gm
*Beans, dried	2 oz - 57 gm
Egusi	1 oz - 28 gm
*Pepper, fresh, red	1 oz - 28 gm
Sugar	8 gm
Groundnuts	8 gm
Coffee (when available)	14 gm

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Red palm oil and bread, not included in the list, were consumed. Those items marked (*) were not included in the issue during the period of the study. Yams and fresh peppers were probably omitted because of their high cost and decreased availability due to its being the dry season. Such items as coffee and sugar appear on the daily ration list if the budget allows for their current price. Married troops receive a monetary ration allowance to cover their individual food expenses.

Since the total rations issued for each item daily are computed from the troop census for the day, the ration issue list presented is not a standard, insofar as actual amounts are concerned. The items listed, however, are quite standardized.

Ration Issue and Stores

The daily food issue for all messes is collected from the centrally located Company Stores by the Mess Corporal and his assistants. The food is issued under the direct supervision of the Supply Sergeant. Cereals, tubers, etc., are delivered in burlap sacks, vegetables and fish are in palm baskets, meat is in metal tubs, and oil in metal containers. Dry staples are issued in paper sacks or boxes. The area for issuing food stores consisted of a small building with a porch. Inside, the supplies were kept on storage racks mounted a distance from the concrete floor. A refrigerated room was at the end of the building for storage of perishable foods such as meat and vegetables. A large scale (kg) was used to weigh items as they were portioned and issued. The general appearance of the stores area was clean. The issuing was done from the porch area into military vans.

Food is obtained through contractors who submit bids on a six-month basis.

Menu of the Mess

Table 19 presents the menu as it was planned and prepared during the days of the study. This menu is fairly typical of what is served throughout the week, quite repetitious and monotonous from one day to the next. This was one complaint made by the troops.

The menu has been planned to appeal to the national average preference. It will be noted that the inclusion of a popular carbohydrate food, eba, connotes the national average pattern found throughout Nigeria. Such a carbohydrate food is accompanied by a soup or sauce. Meat soup is served twice daily, and fish is served once a day. The monotony of this planning was interrupted by serving fried meat for one meal of the three days. Bread is served at breakfast once a week. Coffee is served, if budget costs permit it to be included. Sugar is also available, added to the coffee in preparation in the amount of 7.7 gm per man per day, or 1-1/4 ounces per week.

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TABLE 19. MENUS FOR THE THREE-DAY SURVEY PERIOD, COMPANY A MESS, ZARIA, NORTHERN NIGERIA

	Morning	Noon	Evening
Tuesday, February 23	231 Participants Boiled Rice Meat Soup Coffee Sugar	235 Participants Boiled Rice Fish Soup	220 Participants Eba Meat Soup
Wednesday, February 24	197 Participants Fried Meat Bread Coffee Sugar	185 Participants Eba Fish Soup	155 Participants Cooked Rice Meat Soup
Thursday, February 25	214 Participants Cooked Rice Meat Soup Coffee Sugar	191 Participants Eba Fish Soup	196 Participants Cooked Rice Meat Soup

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Yams are served in season. However, their high cost in the area at the time of the survey prevented them from being included as a dietary staple. Beans, being an item of considerable cost, appear on the menu approximately once a fortnight. Sugar cane is issued to the mess two or three times weekly, but amounts were not recorded during the study.

When in season, fresh fruits such as oranges and mangoes are included on the menu two or three times per week. However, none were available at the time of the survey due to their cost.

Vegetables do not appear on the menu as such, but are served daily in the meat and fish soup. The vegetables issued at the time of the survey were native leafy greens such as tete, efo, gbure, dry and fresh onions, and fresh tomatoes. Fresh peppers in season are included in the daily issue and used in the soup. At the time of the survey they were scarce and too costly.

The quality of the vegetables issued deserves comment. Fresh tomatoes were inferior in quality due to poor original quality of the product, poor handling and storage. Although this was not the season for tomatoes, the military continued to purchase them.

Messing Facilities

The building where meals were taken had a concrete floor, a roof, and walls part-way up. The men ate at long tables with benches. Each man brought two dishes, usually earthenware, a cup, and spoon(s) for dining. Following the meal each was responsible for washing his dishware at a nearby tap.

Food was served outside the mess kitchen in the open area between the kitchen and the dining building, where the containers of food were placed on a table. The troops lined up in platoons and were served from the kettles and pots.

The mess kitchen was a concrete building enclosed with walls which were part solid and the rest screened. Open-trench fires were located along one wall. The remaining part of the kitchen was used for food preparation. One water tap and a sink were used for all kitchen needs. The mess personnel consisted of three cooks and three to four helpers. No recipes were used during the course of food preparation, nor were any ingredients measured. All items used in food preparation were issued daily, except for oil and salt.

Food Preparation

Food was prepared fairly continuously throughout the day. As soon as one meal was over, preparation for the next began. Some items required considerable preparation of ingredients and cooking time. This was es-

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pecially true with respect to the soups. Other menu items such as eba, boiled rice, boiled yams, and bread required little or no preparation before cooking.

Eba (fermented cassava) was prepared in the mess by the addition of dry gari to boiling water which is stirred until smooth but stiff. The average amount of eba consumed per man per day for the survey period was 679.0 gm. About 68 percent of the eba prepared was consumed.

Rice consumption over the 3 days of the study was 495.0 gm per man, and the percent consumed from what was prepared averaged 67.8. This is undermilled Nigerian rice prepared by boiling in water, the average cooked weight being 2 to 3 times the raw weight. The amount of raw rice varied from 75--100 lbs per meal depending on the number of men expected. Generally 5 large pots of rice were prepared. Any left over was served at the next meal.

Bread served at one meal during the study replaced eba and rice as the meal staple. One hundred pounds (45,360 gm) of baker's bread were issued for the 197 men in attendance, for an average intake of 237.0 gm per person. Approximately 4 lb (1814.4 gm) were left over. Coffee was served at each of the morning meals. Sugar was added to the coffee before serving.

Meat and fish soup were served on all three days, fish soup being served for the mid-day meal and meat soup for the morning and evening meal. The ingredients used in meat and fish soup are quite similar: palm oil, salt, pounded egusi (melon seed) and groundnuts, onions, a leafy green vegetable, tomatoes, water, and dried fish or fresh beef. The soup is cooked for a considerable length of time.

The meat is boiled in large pots of water for 2--4 hours. During the cooking, the other ingredients are added, the palm oil and green vegetable being added last. The amount of soup prepared on each of the three survey days was 456, 218, and 327 lbs. Each day soup was prepared in three pots for each of which the ingredients were prepared and cooked separately. As there was no measuring of ingredients, such a method increased the inequality of distribution of ingredients. Both the meat soup and the fish soup were very bland in flavor due to the lack of chilli peppers and hence were quite unacceptable to the Nigerian palate. The men commented on this and expressed their dislike for the soups.

Kitchen Waste and Leftover Foods

Each man scrapes his plate leftovers into garbage cans placed outside the eating buildings. After serving is completed, leftover food is returned to the kitchen where it may be added to another item for the next meal or served as is. Considerable plate waste was observed, especially

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of certain items. This could be attributed to several factors. Payday occurred on the second day of the survey period, resulting in considerable decrease in the mess census, but a corresponding adjustment or decrease was not made in the amount of the food cooked. This reflected in the amount of food not consumed in relation to the amount that had been prepared. Food not served at one meal was included at the next meal time. It must be recognized, however, that if a substantial amount of a particular food item is left over and is to be served at the next meal, a corresponding adjustment must be made in the amount prepared for the next meal. This appears to have been given little consideration by mess personnel of Company A. The problem of waste then should be considered in terms of overpreparation. Plate waste appears to be another subject of concern. Plate waste as high as 40 percent in one item, eba (see Table 20) requires further study at this mess.

Results of the Study

Nutrient intakes in this mess are presented for the chemical composite analysis in Table 24. The nutrient intakes as calculated from tables of food composition are given in Table 26. The results are discussed at the end of this chapter on military dietary studies.

Federal School Feeding Program, Lagos

At the request of the Ministry of Education of the Federal Government of Lagos and with the interest of U.S. Food for Peace and AID officials in Nigeria, the dietary team spent two days visiting the Pilot Program in School Feeding in the Federal District of Lagos. This program being tested in two schools in the area is a coordinated activity of the Federal Government of Nigeria, the Lagos City Council, the U.S. Food for Peace Program, and the private "Meals for Millions" organization.

The amounts and kinds of food items planned to be fed to the children for lunch for each school day are shown in Table 21. The nutrient contributions of these lunches to the nutrient intake of the child are presented in Table 22.

A comparison of the quantity of each food item available to each child each day should be made with the amount designated by the ration. Four cereal foods, semolina, rice, bulgur wheat, and cornmeal, provide 55--65 percent of the total calories of the school meal. Protein in the meal ranges from 17.3 to 21.6 gm, depending upon the type of cereal in the meal, and whether the soup is made with meat or fish.

The difference in the nutrients actually consumed and those available is due to the fact that the latter figures were calculated on a weekly basis. Some of the foods from which available nutrients were

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TABLE 20. FOOD CONSUMPTION AND WASTE STUDY, COMPANY A MESS, ZARIA, NORTHERN NIGERIA

Day	No. Men Served	Meal	Food Item	Total Amount Prepared (cooked wt) (lb)	Amount Not Consumed (lb)	Plate Scrapings		Total Food Consumed (lb)	% Consumed
						Amount (lb)	% of Amount Prepared		
1	235	Noon	Rice	446	---	89	19.95	357	80
1	220	Even-ing	Eba	461	---	182	39.47	279	60
2	185	Noon	Eba	443	77	39	8.8	327	74
2	155	Even-ing	Rice	316	81	116	36.7	119	37
2	155	Even-ing	Meat soup	218	62	90 with bone	41.2	66	30
3	191	Noon	Eba	396	49	70	17.6	277	70
3	191	Noon	Fish soup	169	54	49	28.99	66	31
3	196	Even-ing	Rice	382	55	40	10.5	287	75

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TABLE 21. FOOD RATION PER STUDENT PER DAY AS DEVISED BY THE NUTRITION COUNCIL FOR THE FEDERAL SCHOOL FEEDING PROGRAM, NIGERIA

First (School) Term, Lagos, Nigeria

Monday		Tuesday	
Foodstuff	Amount per Child	Foodstuff	Amount per Child
Fresh fish (A.P.)	1-1/2 oz	Meat (E.P.)	1-1/4 oz
Multi Purpose Foods	To taste	Multi Purpose Foods	To taste
Red palm oil	1/4 oz	Oroyo (groundnut oil)	1/4 oz
Fresh tomato (if available)	1/4 oz	Fresh tomatoes	1/4 oz
Onion	1/4 oz (1/8)	Onion	1/4 oz
Peppers, fresh, red	1/8 oz (1/16)	Peppers, fresh, red	1/4 oz
Beans	2 oz	Bulgur wheat	2 oz
Milk, fresh	1/4 pt	Dried pralons	To taste
Orange	1/2	Milk, fresh	1/4 pt
Salt	1/16 oz	Salt	1/16 oz

Wednesday		Thursday	
Foodstuff	Amount per Child	Foodstuff	Amount per Child
Fresh fish (A.P.)	1-1/2 oz	Meat (E.P.)	1-1/4 oz
Multi Purpose Foods	To taste	Multi Purpose Foods	To taste
Oroyo	1/4 oz	Red palm oil	1/4 oz
Fresh tomatoes	1/4 oz	Fresh tomatoes	1/4 oz
Onion	1/4 oz	Onion	1/4 oz
Peppers, fresh	1/8 oz	Pepper, fresh, red	1/8 oz
Cornmeal	2 oz	Egusi (fermented melon seed)	1/8 oz
Gbure (elvedu)	--	Vegetable	3/4 oz
Salt	1/16 oz	Crayfish	To taste
Milk, powdered	1 oz	Semovita	2 oz
		Milk, powdered	1 oz

Friday	
Foodstuff	Amount per Child
Fresh fish (A.P.)	1-1/2 oz
Oroyo	1/4 oz
Multi Purpose Foods	To taste
Fresh tomatoes	1/4 oz
Onion	1/4 oz
Peppers, fresh, red	1/8 oz
Rice	2 oz
Orange, fresh	1/2
Salt	1/16 oz

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TABLE 22. CALCULATED NUTRIENT INTAKES FROM FEDERAL SCHOOL FEEDING PROGRAM, LAGOS, NIGERIA, MARCH 1965

	Cal.	Prot. gm	Fat gm	CHO gm	Ca mg	Fe mg	Vit. B Complex T mg	Vit. B Complex R mg	Vit. B Complex N mg	Vit. A I.U.	Vit. C mg
I Calc. 5-d. total	2167	120.7	54.20	298.6	1669.21	14.21	1.136	3.135	12.89	4,166	103.25
II Calc. av./day	433	24.1	11.0	59.7	334.0	2.4	.221	.623	2.57	833	22.2
III Actual total	951	100.5	62.4	253	1541.5	13.2	1.57	2.01	12.55	4,691	85.0
IV Actual average	419	23	12.60	55	330	2.713	.35	.470	2.45	956	18.0
V Actual consumption, Govt. Demonstration School	373	17.3	8.1	54.76	284	2.31	.171	.407	1.99	110	8.5
VI Prescribed for School Lunch, City Council School	379	21.6	5.46	58.48	306.4	2.64	.196	.443	1.23	225	11.3

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calculated were not served on the days of observation. A few of the foods as issued are lesser in amount than that stated in the ration. Preparation or waste loss may account for smaller actual intakes of other foods than the amount indicated in the ration.

The nutrients which vary most between the values calculated from the ration allowance and those from the observed food intake are riboflavin, niacin, and vitamins A and C.

The ration has been designed by the appointed Nutrition Council to provide approximately one third of the child's daily nutritional needs. In most respects it seems to be fulfilling its purpose. The program should be expanded to other areas, and greater advantage taken of this opportunity to teach nutrition to the school children of Nigeria.

Results of the Dietary Studies

Nutrient intakes are presented in Tables 23--26. Tables 23 and 24 give results for civilian families and military messes as determined by chemical analysis of composites of aliquots of raw food samples. Table 25 shows the nutrient values of the diet calculated from observed intakes for civilians and Table 26 gives them for the military.

The following are the main dietary problems and results observed in Nigeria:

1. Intakes of riboflavin are low by both calculated and analyzed results, both in the civilian population and in the military. The food sources of riboflavin are limited.

2. Protein intakes are borderline in a number of locations. While these levels are perhaps adequate for an adult population, protein inadequacy among children could be expected to occur in a nutritional environment of this nature.

3. Thiamine intakes are "low" or borderline in several locations.

4. Values for vitamin C intakes are low in a number of areas, even though serum levels are uniformly high. (see Chapter VII).

5. Except in the Jos area, carotene intakes are very high as indicated by chemical analysis. This can be attributed to the consumption of red palm oil which has a very high carotene content.

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TABLE 23. AVERAGE NUTRIENT INTAKE IN NIGERIAN CIVILIAN FAMILIES BY LOCATION, AS DETERMINED BY CHEMICAL ANALYSIS

Village	Epe	Ballah	Kuru	Agbamere-Ama-udi	Ibusa	Asaba (Town)	Surulere	Osegere
Area	Epe	Ilorin	Jos	Nsukka	Asaba	Asaba	Lagos	Ibadan
No. of Families	9	10	7	10	5	5	12	10
No. of Individuals	69	65	49	68		65	75	53
Nutrients								
Calories	2,560	2,580	1,212	2,728	2,615	2,535	2,300	2,680
Protein, gm	90	60	36	56	35	85	55	65
Fat, gm	20	40	12	72	55	55	80	60
Carbohydrate, gm	505	495	240	464	495	425	340	470
Calcium, mg	975	260	348	464	410	440	530	545
Phosphorus, mg	1,575	1,005	960	1,232	775	950	940	1,340
Iron, mg	32	80	102	81	23.1	38.5	36.5	55
Carotene, mg	12.5	16.0	1.5	47.2	12.0	35.5	6.0	14.0
I.U.	20,838	26,672	2,501	78,682	20,004	59,179	10,002	23,338
Thiamine, mg	1.50	1.08 1/	0.80	0.80	0.50	0.50	0.50	1.00
Riboflavin, mg	1.00	0.54 1/	0.40	0.72	0.60	0.70	0.70	0.50
Niacin, mg	20.0	7.5 1/	9.6	3.5	8.0	4.2	8.0	6.8
Ascorbic acid, mg	61.5	39.0	20.8	52.0	42.0	42.0	21.5	21.5
Folic acid, µg	138	80	46	80	63	63	71	93
Dry matter, gm	682	645	400	640	615	595	505	605

1/ Calculated values; chemical values not available. Cooking losses considered.

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TABLE 24.

SUMMARY OF AVERAGE NUTRIENT INTAKE IN NIGERIAN MILITARY CATERING MESSES BY CHEMICAL ANALYSIS

Unit Location	1st Bn. Enugu	4th Bn. Ibadan	NMS Zaria	Co. A Zaria
No. of Rations		194	635	608
No. of Days	3	3	3	3
Nutrients				
Calories	2,904	3,258	3,276	2,936
Protein, gm	80	72	96	89
Fat, gm	24	50	60	36
Carbohydrate, gm	592	630	588	564
Calcium, mg	344	741	1,152	1,513
Phosphorus, mg	1,024	1,123	1,680	2,006
Iron, mg	49	69	154	143
Carotene, mg	1/	24.5	25.8	10.8
I.U.	--	40,842	43,009	18,004
Thiamine, mg	0.8	0.55	1.20	0.59
Riboflavin, mg	0.72	0.66	0.90	0.65
Niacin, mg	13.9	14.2	25.9	30.2
Ascorbic acid, mg	15.2	34.8	32.4	32.1
Folic acid, µg	1/	82	90	88
Dry matter, gm	728	802	798	742

1/ Values not available.

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TABLE 25. NUTRIENT INTAKE PER PERSON PER DAY (RECIPE METHOD), CIVILIAN--NIGERIA, 1965

(Calculated from Food Composition Tables)

		Ballah	Kuru	Nsukka	Ibusa	Asaba Town	Lagos	Osegere
Calories		2286	2192	2435	1851	2150	2176	2111
Protein, gm.		49	57	48	36	62	56	42
Fat, gm.		43	24	45	31	50	40	82
Carbohydrate, gm.		424	535	402	359	340	392	323
Calcium, mg.		422	159	352	545	1040	654	352
Iron, mg.		40	20	23	15	59	21	16
Thiamine, mg.	--Raw	1.43	1.86	1.44	1.08	.87	.78	.84
	--Cooked	1.08	1.40	1.08	.81	.65	.59	.63
Riboflavin, mg.	--Raw	.72	.60	.73	.61	1.40	.55	.44
	--Cooked	.54	.45	.54	.46	1.05	.41	.33
Niacin, mg.	--Raw	10.0	13.6	9.9	7.7	9.1	8.7	6.0
	--Cooked	7.5	10.2	7.4	5.8	6.8	6.5	4.5
Vitamin A, I.U		12,984	2021	7296	4263	7483	5345	13,064
Vitamin C, mg.	--Raw	71.8	33.0	147.5	181.0	137.7	63.3	63.4
	--Cooked	35.9	16.5	73.7	90.5	68.9	31.6	31.7

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TABLE 26. NUTRIENT INTAKE PER PERSON PER DAY (RECIPE METHOD), MILITARY--NIGERIA, 1965

(Calculated from Food Tables)

		N.M.S. Zaria	Company A Zaria
Calories		2760	2940
Protein, gm		77	117
Fat, gm		60	62
Carbohydrate, gm		476	479
Calcium, mg		537	472
Iron, mg		28	21
Thiamine, mg	--Raw	1.33	.89
	--Cooked	1.00	.67
Riboflavin, mg	--Raw	2.70	.83
	--Cooked	2.03	.62
Niacin, mg	--Raw	19.5	20.6
	--Cooked	14.6	15.5
Vitamin A, I.U.		5260	3750
Vitamin C, mg	--Raw	101.5	90.0
	--Cooked	50.7	45.0

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VII

BIOCHEMICAL RESULTS

Blood and urine samples were obtained for biochemical evaluation from a subsample of the population receiving detailed physical examinations. Blood samples were drawn by venipuncture using ethylene diamine tetra acetic acid (EDTA) as an anticoagulant and preserved by immediately placing the tube in a mixture of ice and water. Urine samples were collected, immediately acidified to a pH of 2--3 with 1 N HCl and transferred to amber bottles. Blood and urine samples were generally received within 12 hours after collection and, in all cases, within 24 hours. The procedures described in the ICNND Manual (1) were employed for the various determinations made on the blood and urine specimens. Plasma cholesterol was determined by a modification of the procedure reported by Searcy and Bergquist (2).

The distribution of the biochemical sample with respect to age, sex, and location for the civilian, military, and police is shown in Tables 27 and 28 respectively. (Infants and preschool children, 0--4 years of age, are not included here, but are separately presented in Table 75, Chapter IX). As can be seen, 539 samples were obtained from the civilian population aged 5 or above, 93 from the military, and 15 from the police. In addition, 109 pediatric samples were evaluated, and the distribution of this sample with regard to age and sex is shown in Table 75, Chapter IX.

The data were classified into "deficient", "low", "acceptable", or "high" categories as defined for the various age and sex groups in the ICNND Manual (1). The guide for classification employed is illustrated in Tables 29, 30, and 31.

Civilian Population Above 5 Years of Age

Protein Status

In general, the protein status of the civilian population above 5 years of age appeared to be satisfactory. Very few of the 468 samples analyzed for total protein were in the "deficient" or "low" range (Table 32). A greater percentage of the total sample exhibited low plasma albumin levels (Table 33), suggesting that, particularly in pregnant and lactating females, the protein nutriture of the population might be studied in greater detail. The plasma globulin levels were generally high (Table 34), as has been found in studies of populations in Southeast Asia (3--6), and this is reflected in low albumin/globulin (A/G) ratios (Table 35).

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TABLE 27. AGE DISTRIBUTION OF NONPREGNANT, NONLACTATING AND PREGNANT OR LACTATING FEMALES IN THE BIOCHEMICAL SAMPLE, NIGERIA

	Nonpreg. Nonlact.			Pregnant Lactating		
Age Group (years)	5 - 14	15+	Total	5 - 14	15+	Total
Location						
Derived Savannah	9	13	22	--	29	29
Savannah	6	--	6	--	--	--
Plateau	3	3	6	1	25	26
Urban Fed. Dist.	26	6	32	--	18	18
Rain Forest	32	12	44	--	38	38
Coastal	14	16	30	--	15	15
Total	90	50	140	1	125	126
Percent	64.3	35.7	--	0.7	99.3	--

TABLE 28. AGE DISTRIBUTION OF MALES (CIVILIAN, MILITARY, POLICE) IN THE BIOCHEMICAL SAMPLE, NIGERIA

	Civilian			Military	Police
	5-14	15+	Total		
Location					
Derived Savannah	39	54	93	18	--
Savannah	22	11	33	39	--
Plateau	8	5	13	--	--
Urban Fed. Dist.	18	14	32	29	15
Rain Forest	13	21	34	17	--
Coastal	39	29	68	--	--
Total	139	134	273	93	15
Percent	50.9	49.1	--	--	--

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TABLE 29. INTERPRETATIVE GUIDE TO BIOCHEMICAL DATA FOR CHILDREN (0-5 years), NIGERIA

	"Deficient"	"Low"	"Acceptable"	"High"
Plasma Protein (gm/100 ml)	< 6.0	6.0-6.4	6.5-6.9	≥ 7.0
Albumin (gm/100 ml)	< 2.8	2.8-3.4	3.5-4.2	≥ 4.3
Globulin (gm/100 ml)	< 2.0	2.0-2.9	3.0-3.5	> 3.5
A/G Ratio	< 0.5	0.5-0.9	1.0-1.4	≥ 1.5
Vitamin A (µg/100 ml)	<10	10-19	20-49	≥50
Plasma Carotene (µg/100 ml)	<20	20-39	40-99	≥100
Plasma Vitamin C (mg/100 ml)	< 0.10	0.10-0.19	0.20-0.39	≥ 0.40
Hematocrit (percent)	<30.0	30.0-33.9	34.0-36.9	≥ 37.0
Hemoglobin (gm/100 ml)	<10.0	10.0-10.9	11.0-11.9	≥ 12.0
Mean Corpuscular Hemoglobin Concentration (percent)	<28.0	28.0-29.9	30.0-31.9	≥ 32.0
Urinary excretion/gm creatinine:				
Iodine (µg)	--	--	--	--
Thiamine (1-3 years) (µg)	<120	120-175	176-600	>600
Thiamine (4-5 years) (µg)	< 85	85-120	121-400	>400
Riboflavin (1-3 years)(µg)	<150	150-499	500-900	>900
Riboflavin (4-5 years)(µg)	<100	100-299	300-600	>600
N'-Methylnicotinamide (mg)	< 0.50	0.50-1.59	1.60-4.29	≥ 4.30

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TABLE 30. INTERPRETATIVE GUIDE TO BIOCHEMICAL DATA FOR MALES AND FEMALES, 15+ Years NIGERIA

	"Deficient"	"Low"	"Acceptable"	"High"
Plasma Protein (gm/100 ml)	< 6.0	6.0-6.4	6.5-6.9	≥ 7.0
Albumin (gm/100 ml)	< 2.8	2.8-3.4	3.5-4.2	≥ 4.3
Globulin (gm/100 ml)	< 2.0	2.0-2.9	3.0-3.5	>3.5
A/G Ratio	< 0.5	0.5-0.9	1.0-1.4	≥ 1.5
Vitamin A (µg/100 ml)	<10	10-19	20-49	≥50
Plasma Carotene (µg/100 ml)	--	20-39	40-99	≥100
Plasma Vitamin C (mg/100 ml)	< 0.10	0.10-0.19	0.20-0.39	≥ 0.40
Hematocrit (percent)	<30.0	30.0-33.9	34.0-36.9	≥37.0
Hemoglobin (gm/100 ml)	<10.0	10.0-10.9	11.0-11.9	≥12.0
Mean Corpuscular Hemoglobin Concentration (percent)	<28.0	28.0-29.9	30.0-31.9	≥32.0
Urinary excretion/gm creatinine:				
Iodine (µg)	<50	50-99		≥100
Thiamine (µg)	<27	27-65	66-129	≥130
Riboflavin (µg)	<27	27-79	80-269	≥270
N¹ Methylnicotinamide (mg)	< 0.5	0.50-1.59	1.60-4.29	≥ 4.30

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TABLE 31. INTERPRETATIVE GUIDE TO BIOCHEMICAL DATA FOR PREGNANT OR LACTATING FEMALES, NIGERIA

	Deficient	Low	Acceptable	High
Plasma Protein (gm/100 ml)	< 5.5	5.5-5.9	6.0-6.9	≥ 7.0
Albumin (gm/100 ml)	< 3.0	3.0-3.4	3.5-4.4	≥ 4.5
Globulin (gm/100 ml)	< 1.4	1.4-1.9	2.0-2.9	≥ 3.0
A/G Ratio	< 0.5	0.5-0.9	1.0-1.4	≥ 1.5
Vitamin A (μg/100 ml)	<10	10-19	20-49	≥50
Plasma Carotene (μg/100 ml)	<30	30-79	80-199	≥200
Plasma Vitamin C (mg/100 ml)	< 0.10	0.10-0.19	0.20-0.39	≥ 0.40
Hematocrit (Percent)	<30.0	30.0-34.9	35.0-37.9	≥ 38.0
Hemoglobin (gm/100 ml)	< 9.0	9.0-9.9	10.0-12.9	≥ 13.0
Mean Corpuscular Hemoglobin Concentration (Percent)	<28.0	28.0-29.9	30.0-34.9	≥ 35.0
Urinary excretion/gm creatinine:				
Iodine (μg)	<50	50-99		≥100
Thiamine (μg)	<23	23-54	55-109	≥110
Riboflavin (μg)	<39	39-119	120-399	≥400
N'-Methylnicotinamide (mg)	< 0.60	0.60-1.99	2.00-4.99	≥ 5.00

TABLE 32. TOTAL PLASMA PROTEIN LEVELS, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or Lactating Females
Number of subjects	107	76	120	41	124
Mean (gm/100 ml)	7.55	7.59	7.58	7.61	7.09
		Percent Distribution			
"Deficient"	0	0	0.8	0	0
"Low"	1.9	0	1.7	2.4	0
"Acceptable"	10.3	7.9	7.5	12.2	46.8
"High"	87.9	92.1	90.0	85.4	53.2

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TABLE 33. PLASMA ALBUMIN LEVELS, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	107	75	115	41	123
Mean (gm/100 ml)	3.39	3.44	3.55	3.38	2.97
		Percent Distribution			
"Deficient"	13.1	8.0	7.8	7.3	57.7
"Low"	35.5	45.3	35.7	46.3	22.0
"Acceptable"	50.5	41.3	48.7	41.5	19.5
"High"	0.9	5.3	7.8	4.9	0.8

TABLE 34. PLASMA GLOBULIN LEVELS, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	107	75	114	41	123
Mean (gm/100 ml)	4.19	4.15	4.04	4.25	4.12
		Percent Distribution			
"Deficient"	0	0	0.9	0	0
"Low"	0.9	2.7	2.6	0	0
"Acceptable"	15.9	21.3	20.2	19.5	2.4
"High"	83.2	76.0	76.3	80.5	97.6

TABLE 35. A/G RATIO, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	107	75	114	41	123
Mean	0.83	0.87	0.94	0.82	0.75
		Percent Distribution			
"Deficient"	0.9	5.3	2.6	2.4	11.4
"Low"	77.6	64.0	62.3	75.6	77.2
"Acceptable"	21.5	29.3	33.3	22.0	10.6
"High"	0	1.3	0.9	0	0.8

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Vitamin Status

Thiamine. The data on urinary thiamine excretion (Table 36) reflect a "low" or "deficient" intake of thiamine in a significant percentage of the population, 21% to 40% in the various population categories. These data suggest that a sizable portion of the population is consuming marginal quantities of thiamine. Over half the population studied had "adequate" or "high" excretion values of thiamine, demonstrating satisfactory intakes.

Riboflavin. The most pronounced nutritional problem as judged by biochemical criteria is low nutriture with respect to riboflavin (Table 37). The majority of the civilian population of 471 individuals studied exhibited urinary riboflavin values which are considered to indicate low or deficient nutriture. Biochemical results indicated deficient intakes of riboflavin in 24--67 percent of the sample examined and "deficient" or "low" intakes in 83--94 percent. Of the total civilian population above age 5, fewer than 1 percent had urinary riboflavin values consistent with a "high" intake of the nutrient.

N'-Methylnicotinamide. The intake of niacin and its precursors appears to be nearly adequate as judged from the excretion of N'-methylnicotinamide (Table 38). In all groups examined a majority of the population showed "acceptable" or "high" urinary excretion levels, and only a small percentage could be classified as "deficient."

The usefulness of this biochemical measure as an index of nutriture is less than that of either riboflavin or thiamine. Wide variations in excretion are encountered in well nourished populations and tend to minimize the significance of the small number of values in the "deficient" category. Despite this, the nutriture in regard to niacin is not high. One fifth to one third of the values for adults were classified as "low."

Vitamin A. Except in the pregnant and lactating women, there was little biochemical evidence of vitamin A deficiency in the population group above age 5 (Table 39). The few individuals examined who had "low" or "deficient" plasma vitamin A levels were either younger children or pregnant or lactating women. The plasma carotene levels were extremely high (Table 40) for virtually the entire group studied. The high carotene levels undoubtedly reflect the widespread high intakes of carotene, primarily from red palm oil.

Vitamin C. There was practically no evidence (Table 41) of ascorbic acid deficiency in the population group studied. The great majority of values within all groups are "high."

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TABLE 36. URINARY THIAMINE EXCRETION, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	113	74	119	39	110
Median (μg/gm creatinine)	286	230	87	99	103
		Percent Distribution			
"Deficient"	1.8	6.8	9.2	2.6	4.5
"Low"	23.9	23.0	31.1	25.6	16.4
"Acceptable"	31.9	50.0	33.6	33.3	33.6
"High"	42.5	20.3	26.1	38.5	45.5

TABLE 37. URINARY RIBOFLAVIN EXCRETION, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	119	73	123	41	115
Median (μg/gm creatinine)	61	60	36	47	44
		Percent Distribution			
"Deficient"	64.7	67.1	30.1	24.4	37.4
"Low"	28.6	28.8	56.9	58.5	52.2
"Acceptable"	5.9	4.1	12.2	14.6	9.6
"High"	0.8	0	0.8	2.4	0.8

TABLE 38. URINARY N'-METHYLNICOTINAMIDE EXCRETION, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	114	71	113	34	111
Median (mg/gm creatinine)	3.3	3.4	1.9	2.8	3.4
		Percent Distribution			
"Deficient"	0.9	2.8	2.7	0	0.9
"Low"	5.3	9.9	32.7	20.6	20.7
"Acceptable"	61.4	52.1	57.5	58.8	45.9
"High"	32.5	35.2	7.1	20.6	32.4

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TABLE 39. PLASMA VITAMIN A LEVELS, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	100	65	110	37	116
Mean (μg/100 ml)	39.1	44.7	59.8	56.1	47.7
		Percent Distribution			
"Deficient"	1.0	0	0	0	1.7
"Low"	4.0	6.2	0	0	2.6
"Acceptable"	76.0	56.9	30.9	40.5	44.0
"High"	19.0	36.9	69.1	59.5	51.7

TABLE 40. PLASMA CAROTENE LEVELS, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	100	65	110	37	116
Mean (μg/100 ml)	247	278	281	285	284
		Percent Distribution			
"Low"	0	0	0	0	3.4
"Acceptable"	3.0	0	1.8	0	20.7
"High"	97.0	100.0	98.2	100.0	75.9

TABLE 41. PLASMA VITAMIN C LEVELS, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	109	72	83	34	119
Mean (mg/100 ml)	1.70	1.71	1.40	1.22	1.11
		Percent Distribution			
"Deficient"	0	0	0	0	0.8
"Low"	0	0	0	0	1.7
"Acceptable"	1.8	5.6	4.8	5.9	10.1
"High"	98.2	94.4	95.2	94.1	87.4

TABLE 42. HEMOGLOBIN LEVELS, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	114	78	123	41	124
Mean (gm/100 ml)	11.8	11.6	13.4	12.1	10.9
		Percent Distribution			
"Deficient"	11.4	9.0	14.6	9.8	7.3
"Low"	15.8	21.8	52.0	12.2	16.9
"Acceptable"	29.8	29.5	23.6	65.9	71.0
"High"	43.0	39.7	9.8	12.2	4.8

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Mineral Status

Anemia. The data presented in Tables 42, 43, and 44 indicate that a moderate degree of anemia was widespread in the population examined. The "low" to "deficient" categories of mean corpuscular hemoglobin concentration signify that an appreciable amount of this anemia is of the iron-deficient type. It is of interest that anemia was at least as prevalent among males as among females.

Iodine. The values for urinary iodine excretion (Table 45) show that a percentage of the population is ingesting an inadequate amount of iodine.

Plasma Cholesterol. Plasma cholesterol values were lower than those usually observed in European or American populations (Table 46). By contrast with Europe and America, females had generally higher values than did males.

Military and Police

Protein Status

The protein nutriture of the Armed Forces and police appeared to be satisfactory as judged by plasma total proteins, albumin and globulin levels, and also by albumin/globulin ratios (Tables 47, 48, 49, 50). Of 101 plasma samples evaluated, none would be considered to reflect a "deficient" protein intake, and only a few (approximately 10 percent) might be considered to suggest a marginal dietary protein level. Fewer "low" or "deficient" values occurred among the military and police than were seen among the civilian males. A significant number of the globulin values were high and contributed to low A/G ratios. These observations are similar to findings for several countries in Southeast Asia (3--6) and probably reflect a high incidence of infection.

Vitamin Status

Thiamine. The distribution of values for urinary thiamine recorded in Table 51 reveals that the intake of this nutrient by the military is inadequate, a much higher percentage of unsatisfactory values occurring among the military than among civilian males. The data show that less than half of the personnel examined had urinary thiamine values which reflected an adequate intake of this vitamin. Excretion values suggestive of a "deficient" thiamine intake were observed in 29 percent of the samples examined, implying that the problem is rather acute and should receive prompt attention. The thiamine status of the civilian population was better than that of the military (compare Tables 36 and 51). This may be the result of a greater caloric expenditure by the military. Insufficient

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TABLE 43. HEMATOCRIT VALUES, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	114	78	120	41	124
Mean percent	37.0	36.5	42.6	38.0	35.0
			Percent Distribution		
"Deficient"	2.6	3.8	4.2	2.4	9.7
"Low"	19.3	12.8	33.3	36.6	34.7
"Acceptable"	21.1	30.8	31.7	48.8	25.8
"High"	57.0	52.6	30.8	12.2	29.8

TABLE 44. MEAN CORPUSCULAR HEMOGLOBIN CONCENTRATION, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+		Pregnant or lactating females
Number of subjects	114	78	120	41		124
Mean	31.8	31.6	31.4	31.8		31.4
			Percent Distribution			
< 28.0	2.6	2.6	5.0	0	< 28.0	4.0
28.0 - 29.9	11.4	12.8	10.8	14.6	28.0 - 29.9	17.7
30.0 - 31.9	42.1	44.9	45.0	46.3	30.0 - 34.9	72.6
≥ 32.0	43.9	39.7	39.2	39.0	≥ 35.0	5.6

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TABLE 45. URINARY IODINE EXCRETION, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	39	30	26	12	41
Mean (µg/gm creatinine	152	122	131	224	156
			Percent Distribution		
"Deficient"	7.7	10.0	19.2	8.3	2.4
"Low"	38.5	40.0	53.8	25.0	46.3
"Adequate"	53.8	50.0	26.9	66.7	51.2

TABLE 46. PLASMA CHOLESTEROL LEVELS, CIVILIAN POPULATION, NIGERIA

Description Age (years)	Male 5-14	Female 5-14	Male 15+	Female 15+	Pregnant or lactating females
Number of subjects	106	73	118	39	123
Mean (mg/100 ml)	132	144	143	162	182
			Percent Distribution		
50 - 99	20.8	16.4	7.6	7.7	1.6
100 - 149	46.2	37.0	52.5	23.1	17.1
150 - 199	30.2	37.0	33.9	56.4	48.8
≥ 200	2.8	9.6	5.9	12.8	32.5

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TABLE 47. TOTAL PLASMA PROTEIN LEVELS, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	86	15
Mean (gm/100 ml)	7.53	8.21
	Percent Distribution	
"Deficient"	-	-
"Low"	-	-
"Acceptable"	5.8	-
"High"	94.2	-

TABLE 48. PLASMA ALBUMIN LEVELS, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	81	15
Mean (gm/100 ml)	3.90	3.82
	Percent Distribution	
"Deficient"	-	-
"Low"	13.6	-
"Acceptable"	72.8	-
"High"	13.6	-

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	Military	Police
Number	81	15
Mean (gm/100 ml)	3.66	4.39
	Percent Distribution	
"Deficient"	-	-
"Low"	7.4	-
"Acceptable"	39.5	-
"High"	53.1	-

TABLE 50. A/G RATIO, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	81	15
Mean	1.08	0.88
	Percent Distribution	
"Deficient"	-	-
"Low"	40.7	-
"Acceptable"	54.3	-
"High"	4.9	-

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TABLE 51. URINARY THIAMINE EXCRETION, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	82	15
Median (μg/gm creatinine)	48	68
	Percent Distribution	
"Deficient"	29.3	-
"Low"	28.0	-
"Acceptable"	24.4	-
"High"	18.3	-

TABLE 52. URINARY RIBOFLAVIN EXCRETION, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	86	15
Median (ug/gm creatinine)	38	26
	Percent Distribution	
"Deficient"	29.1	-
"Low"	59.3	-
"Acceptable"	9.3	-
"High"	2.3	-

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samples were obtained from the police to enable any accurate evaluation, but the median excretion value suggests that the intake in this group is also suboptimal and, if the intake is continuous at this level, clinical signs of thiamine deficiency might be encountered.

Riboflavin. The military and police both exhibited "low" median urinary riboflavin excretion values (Table 52). In this population segment, as was observed for the civilians, riboflavin deficiency appeared to be the most common nutritional deficiency. Only 11 percent of the military personnel examined had excretion values indicative of an adequate intake of riboflavin; this is similar to the findings recorded in Table 37 for the civilian population.

N'-Methylnicotinamide. The values recorded in Table 53 for N'-methylnicotinamide excretion are similar to those observed among the civilians, but possibly a somewhat greater percentage is in the "low" category. A high percentage of the military had excretion values reflecting a marginal intake of niacin. However, the very low percentage demonstrating "deficient" excretion levels suggests that the intake is above a critical level and that if a problem does exist, it is not of severe degree.

Vitamin A. The values for plasma vitamin A and its precursor, carotene (Tables 54 and 55), demonstrate the adequacy of the military and police diet so far as vitamin A intake is concerned. The very high levels of plasma carotene are undoubtedly the consequence of the ingestion of red palm oil which has a high carotene content.

Vitamin C. The military and police personnel studied reflected an adequate intake of ascorbic acid as shown in Table 56.

Mineral Status

Anemia. The data presented in Tables 57, 58, 59 for hemoglobin hematocrit and mean corpuscular hemoglobin content indicate that there is but little anemia within the military or police. The few low values recorded appear from the mean corpuscular hemoglobin concentration to reflect an iron deficiency type of anemia.

Iodine. The urinary iodine values for the military and police (Table 60) imply that iodine intakes are inadequate. However, because of the small number of samples, it is impossible to generalize these data.

Plasma Cholesterol.

Plasma cholesterol values for the military and police are presented in Table 61. These values are lower than similar data obtained for European or American populations, but do show a distribution among higher values than the corresponding figures obtained for civilian Nigerian adult men. This may inflect a greater calorie intake or a qualitative difference in the dietary of the military and police.

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TABLE 53. N^1-METHYLNICOTINAMIDE, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	84	15
Median (mg/gm creatinine)	1.8	2.0
	Percent Distribution	
"Deficient"	1.2	-
"Low"	44.0	-
"Acceptable"	47.6	-
"High"	7.1	-

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TABLE 54. PLASMA VITAMIN A LEVELS, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	80	15
Mean (µg/100 ml)	60.3	61.1
	Percent Distribution	
"Deficient"	1.2	-
"Low"	3.8	-
"Acceptable"	22.5	-
"High"	72.5	-

TABLE 55. PLASMA CAROTENE LEVELS, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	80	15
Mean (µg/100 ml)	285	377
	Percent Distribution	
"Deficient"	-	-
"Low"	-	-
"Acceptable"	-	-
"High"	100	-

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TABLE 56. PLASMA VITAMIN C LEVELS, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	89	15
Mean (mg/100 ml)	1.19	0.74
	Percent Distribution	
"Deficient"	-	-
"Low"	1.1	-
"Acceptable"	15.7	-
"High"	83.1	-

TABLE 57. HEMOGLOBIN LEVELS, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	92	15
Mean (gm/100 ml)	143	13.6
	Percent Distribution	
"Deficient"	-	-
"Low"	40.2	-
"Acceptable"	40.2	-
"High"	19.6	-

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TABLE 58. HEMATOCRIT, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	92	12
Mean (percent)	44.7	41.2
	Percent Distribution	
"Deficient"	1.1	-
"Low"	8.7	-
"Acceptable"	40.2	-
"High"	50.0	-

TABLE 59. MEAN CORPUSCULAR HEMOGLOBIN CONCENTRATION, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	92	12
Mean	32.0	32.7
	Percent Distribution	
"Deficient"	2.2	-
"Low"	8.7	-
"Acceptable"	37.0	-
"High"	52.2	-

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TABLE 60. URINARY IODINE EXCRETION, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	25	9
Median (ug/gm creatinine)	70	37
	Percent Distribution	
"Deficient"	36.0	-
"Low"	48.0	-
"Adequate"	16.0	-

TABLE 61. PLASMA CHOLESTEROL LEVELS, MILITARY AND POLICE, NIGERIA

	Military	Police
Number	83	15
Mean (mg/100 ml)	168	160
	Percent Distribution	
<100	-	-
100 - 149	33.7	-
150 - 199	53.0	-
≥ 200	13.3	-

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VIII

PARASITOLOGIC STUDIES

The total number of individuals studied in Nigeria for presence of parasites in feces or blood specimens is presented by region, sex, and age in Table 62.

The prevalence of intestinal parasites was estimated on the basis of 380 stool specimens preserved in the field and examined at the Naval Medical Research Unit No. 3 (NAMRU-3), Cairo, U.A.R. The prevalence of blood parasites was estimated on the basis of 660 pairs of blood smears (thick and thin) fixed and stained by technicians at the University College Hospital, Ibadan, Nigeria, and examined at NAMRU-3. Additional specimens were unusable and were discarded. Differential leucocyte counts were performed on 540 of the thin blood smears. Table 63 shows all of the intestinal parasites that were detected in the survey. It must be considered a rough underestimate of the true parasite load of the persons examined. Table 64 indicates the prevalence of the principal intestinal parasites found in the civilian population sampled. The limited usefulness of the standard parasitologic methods employed in the survey is indicated by the finding of only eight cases of schistosomiasis, a parasitic infestation known to be widespread over Nigeria.

Extremely heavy infestations with Ascaris were found only in Lagos, especially among the children of St. John's Primary School, Arolya. Moderate to heavy Ascaris infestations were present in the Western Region. Heavy and moderate infestations with Trichuris were also mainly restricted to Lagos and the Western Region. Hookworm infestation was more prevalent and severe in the eastern parts of Nigeria, although light and moderate infestations were common over all of the surveyed areas (see also Table 65). Parasitic infestations in the 93 Army men examined were rather less prevalent relative to the civilian population, and were much less severe, being light to moderate with rare exceptions.

As had been anticipated, parasitic infestations were heavier in, and more numerous among, school age children than in adults. Infection rates for civilian males and females were not significantly different, nor were the rates for urban and rural populations in general.

Malaria, caused mainly by Plasmodium falciparum and by P.malariae, was found in all regions. Infestation rates were highest in the lush areas around Ibadan, Western Region, Ilorin, Northern Region, and Nsukka, Eastern Region; they were lowest in the dry areas of northern Nigeria (see Tables 66 and 67).

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TABLE 62. NUMBERS OF INDIVIDUALS BY SEX, AGE AND REGION RECEIVING PARASITOLOGIC EXAMINATIONS, NIGERIA

Region	Males							Females, Nonpregnant, Nonlactating						
	Age (years)							Age (years)						
	0-4	5-14	15-24	25-34	35-44	45+	Total	0-4	5-14	15-24	25-34	35-44	45+	Total
Derived Savannah	14	40	36	6	6	6	108	9	9	4	2	3	4	31
Savannah	1	21	13	-	-	-	35	4	6	-	-	-	-	10
Plateau	6	8	2	-	1	2	19	4	3	1	-	1	1	10
Federal District	4	19	2	1	4	1	31	9	26	1	4	-	2	42
Rain Forest	10	14	2	8	5	4	43	9	27	5	-	2	1	44
Coastal	7	14	4	6	8	4	43	4	4	1	4	-	3	16
Total	42	116	59	21	24	17	279	39	75	12	10	6	11	153

Region	Females, Pregnant or Lactating				Military				Police
	Age (years)				Age (years				19-23
	15-24	25-34	35-44	Total	15-24	25-34	35-44	Total	Years
Derived Savannah	18	11	-	29	6	11	1	18	-
Savannah	-	-	-	-	21	-	-	21	-
Plateau	11	13	2	26	-	-	-	-	-
Federal District	9	9	-	18	8	15	7	30	15
Rain Forest	12	9	3	24	9	6	2	17	-
Coastal	2	11	2	15	-	-	-	-	-
Total	52	53	7	112	44	32	10	86	15

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TABLE 63. PREVALENCE OF INTESTINAL PARASITES IN 380 NIGERIANS BASED ON SINGLE STOOL EXAMINATION BY M I F AND M I F C TECHNICS

	No.	Percent
Helminths and/or protozoa	325	86
Helminths only	130	34
Protozoa only	32	8.4
Helminths and protozoa	163	43
No parasites detected	55	14
Helminths		
Ascaris lumbricoides	123	32
Trichuris trichiura	111	29
Hookworm species	214	56
Strongyloides stercoralis	11	2.9
Trichostrongylus species	9	2.4
Enterobius vermicularis	11	2.9
Schistosoma mansoni	7	1.8
Schistosoma haematobium	1	0.3
Hymenolepis nana	2	0.5
Protozoa		
Entamoeba histolytica	85	22
E. histolytica (small race)	13	3.4
Entamoeba coli	141	37
Endolimax nana	60	16
Dientamoeba fragilis	10	2.6
Iodamoeba bütschlii	5	1.3
Giardia lamblia	13	3.4
Chilomastix mesnili	11	2.9
Enteromonas hominis	14	3.7

TABLE 64. PREVALENCE OF THE PRINCIPAL INTESTINAL PARASITES FOUND IN 287 NIGERIAN CIVILIANS, TABULATED BY REGION

Region	Lagos Federal Territory	Western	Northern	Midwestern	Eastern	Total
No. Persons	55	62	59	23	88	287
	Percent Prevalence					
Ascaris lumbricoides	69	78	20	17	3	36
Trichuris trichiura	62	76	10	17	3	33
Hookworm species	31	57	53	87	75	59
Entamoeba histolytica	15	23	30	26	25	24

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TABLE 65. PREVALENCE OF COMBINATIONS OF PARASITES BY REGION, NIGERIA

Parasite	Region: Derived Savannah	Savannah	Plateau	Federal District	Rain Forest	Coastal	Total
No. examined	116	37	41	81	75	30	380
	Percent Prevalence						
Ascaris	--	5.4	2.4	9.9	9.3	6.7	5.3
Ascaris, Trichuris	--	5.4	--	19.8	10.7	10.0	7.6
Ascaris, Hookworm	5.2	5.4	2.4	3.7	5.3	6.7	4.7
Ascaris, E. histolytica	0.9	--	--	--	1.3	--	0.5
Ascaris, Trichuris, Hookworm	2.6	2.7	--	8.6	13.3	30.0	7.9
Ascaris, Trichuris, E. histolytica	--	--	2.4	3.7	4.0	6.7	2.4
Ascaris, Hookworm, E. histolytica	3.4	2.7	2.4	--	1.3	--	1.8
Ascaris, Trichuris, Hookworm, E. histolytica	0.9	--	--	1.2	4.0	10.0	2.1
Trichuris	0.9	8.1	--	1.2	8.0	--	2.9
Trichuris, Hookworm	4.3	2.7	--	6.2	4.0	6.7	4.2
Trichuris, E. histolytica	0.9	--	--	3.7	--	--	1.1
Trichuris, Hookworm, E. histolytica	--	2.7	--	--	1.3	3.3	0.8
Hookworm	44.8	27.0	26.8	12.3	21.3	--	26.1
Hookworm, E. histolytica	15.5	8.1	9.8	2.5	6.7	3.3	8.7
E. histolytica	6.0	8.1	14.6	2.5	--	--	4.7
None found	14.7	21.6	39.0	24.7	9.3	16.7	19.2

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TABLE 66. PRESENCE OF BLOOD PARASITES BY REGION, NIGERIA

Parasite	Region						Total
	Derived Savannah	Savannah	Plateau	Federal District	Rain Forest	Coastal	
No. examined	184	66	55	131	108	71	615
	Percent Prevalence						
Microfilariae							
D. perstans	7.6	3.0	--	1.5	1.9	2.8	3.6
W. bancrofti	0.5	--	--	--	--	--	0.2
Loa loa	2.2	--	--	1.5	1.9	2.8	1.6
Any	9.8	3.0	--	3.1	3.7	5.6	5.2
Malaria							
P. falciparum	21.2	1.5	--	0.8	23.1	4.2	11.2
P. malariae	4.3	--	--	--	9.3	1.4	3.1
P. ovale	0.5	--	--	0.8	--	--	0.3
Any	26.1	1.5	--	1.5	31.5	5.6	14.5

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TABLE 67. PRESENCE OF BLOOD PARASITES BY SEX AND AGE, NIGERIA

	Males							Females, Nonpregnant, Nonlactating						
	0-4	5-14	15-24	25-34	35-44	45+	Total	0-4	5-14	15-24	25-34	35-44	45+	Total
No. examined	42	113	59	16	20	15	265	39	67	11	10	6	11	144
	Percent Prevalence													
Microfilariae														
D. perstans	--	4.4	--	18.8	5.0	13.3	4.2	--	3.0	9.1	--	33.3	9.1	4.2
W. bancrofti	--	--	1.7	--	--	--	0.4	--	--	--	--	--	--	--
Loa loa	--	0.9	--	--	--	6.7	0.8	--	1.5	9.1	--	--	--	1.4
Any	--	4.4	1.7	18.8	5.0	20.0	4.9	--	4.5	18.2	--	33.3	9.1	5.6
Malaria														
P. falciparum	16.7	23.1	5.1	12.5	5.0	6.7	15.1	12.8	19.4	27.3	--	50.0	--	16.7
P. malariae	11.9	6.2	1.7	6.2	5.0	--	5.7	--	4.5	9.1	--	--	--	2.8
P. ovale	---	--	--	6.2	--	--	0.4	--	--	--	--	--	--	--
Any	26.2	29.2	6.8	25.0	10.0	6.7	20.8	12.8	23.9	36.4	--	50.0	--	19.4

	Females, Pregnant or Lactating				Military				Police
	Age (years)				Age (years)				
	15-24	25-34	35-44	Total	15-24	25-34	35-44	Total	
No. examined	50	53	5	108	42	32	9	83	15
	Percent Prevalence								
Microfilariae									
D. perstans	2.0	--	20.0	1.9	--	6.2	--	2.4	6.7
W. bancrofti	--	--	--	--	--	--	--	--	--
Loa loa	4.0	7.5	--	5.6	--	--	--	--	--
Any	6.0	7.5	20.0	7.4	--	6.2	--	2.4	6.7
Malaria									
P. falciparum	8.0	--	--	3.7	2.4	--	--	1.2	--
P. malariae	--	-	--	--	--	--	--	--	--
P. ovale	2.0	--	--	0.9	--	--	--	--	--
Any	10.0	--	--	4.6	2.4	--	--	1.2	--

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Filariasis, caused by Loa loa and Wuchereria bancrofti, was also widespread, the distribution being similar to that of malaria.

Differential leucocyte counts varied greatly among individuals and between the younger and older age groups, as might be expected (Table 68). The mean counts did not vary markedly from one region to another, however, despite regional differences in the prevalence of Ascaris and hookworm which are notable for their influence on the blood picture (Tables 69 and 70). The mean eosinophil count for the population surveyed was over 10 percent, at least three times higher than the normal count for Americans or Europeans. The mean neutrophil count (35--40 percent) was considerably lower, whereas the mean lymphocyte count (45--50 percent) was higher than is regarded as normal in the Western Hemisphere. The elevated eosinophil counts are clearly attributable to the prevalence of parasitic helminths in the population. The reversal of the neutrophil-lymphocyte ratio is not so easily explained and may involve dietary or hereditary factors.

The presence of hookworm infestations of varying load is compared with different concentrations of hemoglobin found in the population studied in Table 71. A similar presentation for Ascaris infestation is also given in Table 71. Half of the individuals who had P. falciparum organisms in their blood smears had hemoglobin levels which would be considered "deficient."

Considering the prevalence of parasitic infestations as only one factor, the question arises, what should be considered the "normal" differential count, or for that matter, the "normal" intestinal fauna in Nigeria. The survey was directed at the healthy population of the country; hence, it seems unwarranted to regard as necessarily abnormal the large majority of Nigerians whose statistics do not fit into tables of normal values compiled in the relatively aseptic West. A useful product of such surveys may be the provision of new criteria for defining status of health and disease in developing nations.

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TABLE 68. MEAN NUMBERS OF EOSINOPHILS BY SEX AND AGE IN NIGERIANS IN PARASITOLOGIC STUDY

Sex	Males							Females, Nonpregnant, Nonlactating						
Age (years)	0-4	5-14	15-24	25-34	35-44	45+	Total	0-4	5-14	15-24	25-34	35-44	45+	Total
No. examined	30	100	58	16	19	15	238	23	60	9	10	6	9	117
Mean no. eosinophils	4.3	11.8	13.3	14.0	13.2	10.4	11.4	5.7	7.9	11.6	5.4	13.2	15.7	8.4

Sex	Females, Pregnant				Females, Lactating			
Age (years)	15-24	25-34	35-44	Total	15-24	25-34	35-44	Total
No. examined	32	35	2	69	13	10	2	25
Mean no. eosinophils	6.9	8.4	6.0	7.7	7.2	6.9	6.5	7.0

Group	Military				Police
Age (years)	15-24	25-34	35-44	Total	19-23
No. examined	41	26	9	76	15
Mean no. eosinophils	10.6	7.6	8.8	9.4	10.1

TABLE 69. MEAN NUMBERS OF EOSINOPHILS BY REGION IN NIGERIANS IN PARASITOLOGIC STUDY

Region	Derived Savannah	Savannah	Plateau	Federal District	Rain Forest	Coastal	Total
No. examined	169	63	42	124	82	60	540
Mean no. eosinophils	11.0	14.6	7.1	7.7	7.6	10.2	9.8

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TABLE 70. EOSINOPHIL COUNTS FOR INDIVIDUALS HAVING CERTAIN PARASITIC INFESTATIONS, NIGERIA

Parasite	Trichuris				Ascaris				Hookworm				D. perstans	Loaloa	Total
Parasite load	Light	Moderate	Heavy	Any	Light	Moderate	Heavy	Any	Light	Moderate	Heavy	Any	Total			
Total no.	55	37	18	110	58	39	26	123	119	79	16	214	330	22	10	615
Total no. known	37	29	11	77	38	23	22	83	97	69	16	182	314	20	10	540
	Percent of Total Known															
Eosinophil counts																
0-4	12.0	6.5	2.2	20.7	13.0	5.4	3.3	21.7	29.3	18.5	5.4	53.3	92	0.6	0	167
5-9	11.0	8.0	3.0	22.0	13.0	9.0	9.0	31.0	26.0	28.0	5.0	59.0	100	2.5	3.1	163
10-19	13.5	12.4	5.6	31.5	11.2	9.0	9.0	29.2	34.8	22.5	4.5	61.8	89	5.9	2.6	152
≥20	9.1	12.1	3.0	24.2	9.1	3.0	6.1	18.2	39.4	12.1	6.1	57.6	33	10.3	1.7	58
Unknown	27.3	12.1	10.6	50.0	30.3	24.2	6.1	60.6	33.3	15.2	-	48.5	66	2.7	0	75

TABLE 71. HEMOGLOBIN LEVELS IN INDIVIDUALS WITH HOOKWORM OR ASCARIS, NIGERIA

Parasite	Hookworm						Ascaris				
Parasite load	None	Light	Moderate	Heavy	Any	Total	Light	Moderate	Heavy	Any	Total
Total no. known	159	114	77	15	206	365	58	35	25	118	365
Hemoglobin Level											
"Deficient"	8.2	11.4	28.6	33.3	19.4	14.5	17.0	7.5	5.7	30.2	53
"Low"	30.8	34.2	29.9	46.7	33.5	32.3	13.6	8.5	3.4	25.4	118
"Acceptable"	37.1	31.6	28.6	20.0	29.6	32.9	13.3	11.7	9.2	34.2	120
"High"	23.9	22.8	13.0	0.0	17.5	23.3	23.0	9.5	9.5	41.9	74

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Figure 3. NIGERIAN CHILDREN WAITING FOR CLINICAL EXAMINATIONS

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IX

CLINICAL FINDINGS

Clinical examinations were performed on children less than 5 years of age, on children of school age, on family groups, on pregnant and lactating women, on school children, military personnel, and police cadets. The methods used are outlined in Chapter III. Detailed procedures are described and discussed below for these several groups, along with the results.

Description of the Pediatric Study

In all, 432 children (218 boys and 214 girls) under age 5 years were studied. Of these, 66 boys and 65 girls were less than 1 year of age.

In each of the 6 major geographic areas, the sample consisted of

(a) children seen in infant welfare clinics (mainly urban)
(b) children of families seen in villages (mainly rural).

Two special groups, children of military personnel and children of the administrative staff of a large industrial group, afforded a comparison with the others, most of whom were from lower and lower-middle income families.

Although the infant welfare clinics are designated as "well-baby" clinics, many of the mothers bring their children for treatment rather than prophylaxis.

Hospital clinics were visited and impressions noted, but no actual study was made in such locations. Outlying villages afforded an opportunity of observing the effects of undernutrition and disease in a more realistic setting. The pediatric team consisted of 2 pediatricians, a graduate nurse (Nigerian), other clinicians, nutritionists, and clerical help. The Maternal and Child Health Nurse in charge of each center and her assistants rendered invaluable assistance in every area studied.

Three hundred sixty of the children were examined by one of the pediatricians of the team, 72 by the other. Heights and weights of all children who could not stand were recorded by the pediatrician or the graduate nurse; data on others were recorded by the clerical staff under supervision of the graduate nurse.

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Physical examination followed the format outlined on the pediatric card for children ages 0--4 years. In addition, the presence or absence of yellow palms was noted, since it was felt that it might correlate with laboratory data concerning serum carotene and vitamin A levels. The presence or absence of umbilical hernias also was noted since it early was realized that this is prevalent in young Nigerian children but not in older adults. Similar information concerning umbilical hernia was obtained in most of the older age groups in an attempt to determine the natural history of this defect.

Specimens of blood were obtained by internal jugular puncture. Attempts were made to obtain specimens from 10 children at each center studied, this representing usually every third child. In all, 109 specimens were suitable for biochemical study. Urine specimens were collected in paper cups, under the supervision of the graduate nurse or the physicians working in the laboratory.

Obstetric history and past history were registered by the graduate nurse, usually in cooperation with clinic personnel. Much of this was unreliable (unless obtained from records kept by the clinic). Nigerian women frequently are not sure as to their own age nor the ages of their children. Ages are good approximations for the younger infants and children. "Fever" was recorded, and "fever" and malaria seem usually to be synonymous terms.

Quantitative estimates of dietary intake proved to be unreliable, and in many cases qualitative identification of foods proved also unreliable. Direct questioning as to whether such-and-such foodstuff was given invariably evoked an affirmative answer, which was usually not believed by the local clinic personnel. Attempts were therefore made to record only the duration of breast feeding, addition of milk supplements, and administration of vitamins.

Description of Sample

The examinations were carried out during February and March of 1965, just prior to the rainy season. The total number of children examined was 432 (218 boys, 214 girls). (Table Addenda 1)

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TABLE ADDENDA 1. SAMPLE AND REGION, PEDIATRIC CLINICAL STUDY

Distribution as to Region and Origin

(1) Derived Savannah (Ilorin, Nsukka)
rural - 58
urban - 21 (infant welfare clinic)

(2) Savannah (Zaria)
rural - 22 (infant welfare clinic)

(3) Plateau (Jos)
rural - 24
urban - 31 (infant welfare clinic)

(4) Federal District of Lagos
urban - 72

(5) Rain Forest (Ibadan, Asaba, and Ibusa)
rural - 107 (Osegere village)
urban - 34 (including 23 children of service personnel)

(6) Coastal Area (Epe, Port Harcourt)
rural - 9
urban - 34 (infant welfare clinic)
urban - 20 (children of administrative staff of industrial group)

Distribution as to Age and Sex

Age (years)	Males	Females
0 - 1	66	65
1 - 2	39	52
2 - 3	25	23
3 - 4	44	41
4 - 5	34	23
5+	10	10
	218	214

Number of Children Examined in Each District

Region		Rain Forest	Derived Savannah	Savannah Plateau		Coastal Area
District	Lagos	Ibadan-Asaba	Ilorin-Nsukka	Zaria	Jos	Epe-Port Harcourt
Males	38	66	41	10	25	38
Females	34	75	38	12	30	25
Total	72	141	79	22	55	63

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Results

The clinical findings by location and by age and sex are shown in Tables 72, 73.

Diarrheal Disease

Diarrhea was prevalent in most areas with an incidence generally ranging between 10 and 30 percent. Boys and girls were equally affected. The prevalence in those children attending Infant Welfare Clinics was the same as in those who did not.

Babies under 6 months of age were remarkably free of diarrheal disease (one patient only). In this group 60 percent were breast-fed entirely and another 30 percent received breast milk plus other milk. Diarrhea was most prevalent from the middle of the first year of life through age 3.

Respiratory Disease

Respiratory disease was even more prevalent than diarrhea, with the incidence generally ranging between 25 and 40 percent. Again there was no significant difference between males and females. Those followed in Infant Welfare Clinics appeared to have a higher incidence, but this may have reflected the fact that better records were kept in the clinics, and parents may also have brought in their children with more minor problems due to the educational influence of such clinics. The prevalence in the first 6 months was as high as at any other age.

Malaria

Thirty-three and one third percent of infants under 6 months of age gave a history of malaria or "fever." That this figure is reasonable is borne out by the fact that 25.5 percent of infants under 6 months of age had splenomegaly. Sickle cell anemia is also prevalent in Nigeria and may simulate malaria. The prevalence of fever during the next 6 months period was 25.4 percent and remained at this level during the next 4 years of life.

The prevalence by area was approximately 20 percent, with an unexpected low of 6 percent in the coastal area. However, a close perusal of the tables (Tables 72, 74) reveals that some areas report "fever," others "malaria," and it is probable that they both represent malaria.

The incidence of both "fever" and "malaria" approached zero in the Lagos area, as did the incidence of splenomegaly.

These findings concerning malaria are in general in accord with the experience of Rhea in the Institute of Child Health in Lagos, 1963-65, who also properly emphasized the etiologic role of measles in malnutrition.

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TABLE 72. CLINICAL FINDINGS BY LOCATION, PEDIATRIC SAMPLE, NIGERIA

Location	Lagos		Ibadan		Asaba	Ibusa	Ilorin	Nsukka		Epe		Port Harcourt
Recent History												
No. Reported	32	6	68	6	2	6	14	24	21	7	20	17
Diarrhea					Percent Prevalence							
Current	18.8		11.8				14.3				30.0	5.9
Recent	18.8		13.2	16.7				4.2			10.0	5.9
Recurrent	18.8		20.6			33.3		8.3				5.9
Respiratory Disease												
Current	43.8		29.4	16.7					47.6	42.9	25.0	11.8
Recent	15.6		7.4					4.2				23.5
Recurrent	40.6		14.7									
Other												
Pica			12.9									
Parasites	3.1									28.6	10.0	11.8
Malaria			39.4	16.7		66.7		16.7	90.5			35.3
Fever	3.1		77.6	66.7		33.3	28.6	4.2	33.3	14.3	30.0	
Cough	6.2		13.2	66.7				4.2	38.1			5.9
Boils	25.0				50.0			12.5	4.8			
No. Examined	33	39	101	23	11	6	24	34	21	9	34	20
General Impression					Percent Prevalence							
Apathy	3.0	5.1	7.9	8.7				2.9	23.8	11.1	11.8	
Pallor				8.7	18.2			5.9	28.6			
Irritability	9.1	2.6	5.9	8.7	9.1			5.9	28.6			
Clinical Impression												
Marasmus							4.2	2.9	9.5			
Prekwashiorkor								2.9			2.9	
Kwashiorkor											2.9	
Good	69.7	23.1		60.0	72.7	83.3	4.2	64.7	33.3	22.2	20.6	60.0
Fair									4.8			
Poor		2.6								11.1		
Unspecified	30.3	74.4	100.0	40.0	27.3	16.7	95.8	35.3	61.9	66.7	79.4	40.0
Hair												
Dry staring		2.6										
Dyspigmentation		2.6	1.0									
Thin		2.6		4.3								
Easily pluckable	3.0	5.1	1.0									

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TABLE 72. (Continued). CLINICAL FINDINGS BY LOCATION, PEDIATRIC SAMPLE, NIGERIA

Location	Lagos		Ibadan		Asaba	Ibusa	Ilorin	Nsukka		Epe		Port Harcourt
No. Examined	33	39	101	23	11	6	24	34	21	9	34	20
Eyes					Percent Prevalence							
Conjunctivitis	3.0		1.0									
Lips												
Angular lesions	3.0	2.6	5.0	4.3			4.2				11.8	
Cheilosis			1.0									
Gums												
Swollen red papillae-diffuse			12.9				8.3	5.9	4.8	11.1	5.9	
Bleeding			4.0				4.2	5.9	4.8	11.1	2.9	5.0
Tongue												
Filiform papillary atrophy - mild		2.6	1.0				4.2					
- moderate		2.6						2.9				
Glossitis			1.0						4.8			
Thyroid Enlarged												
Grade I	3.0	17.9	1.0		9.1		4.2	14.7		2.9		
Grade II		2.6										
Grade not stated		7.7										
Skin												
Inelastic		2.6						2.9				
Dermatitis		2.6						2.9				
Abdomen												
Hepatomegaly	30.3	41.0	31.7	13.0	54.5	66.7	70.8	73.5	95.2	55.6	35.3	75.0
Splenomegaly	3.0		24.8	17.4	18.2	16.7	75.0	50.0	71.4	55.6	20.6	40.0
Potbelly	6.1	2.6	10.9						9.5	11.1	11.8	5.0
Lower Extremities												
Bilateral edema			1.0						5.9		2.9	
Skeletal												
Costochondral beading		5.1	4.0	4.3			4.2		4.8			
Enlarged joints										11.1		
Muscle wasting			4.0	13.0				2.9	9.5	22.2		

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TABLE 72. (continued). CLINICAL FINDINGS BY LOCATION, PEDIATRIC SAMPLE, NIGERIA

Location	Lagos		Ibadan		Asaba	Ibusa	Ilorin	Nsukka		Epe		Port Harcourt
No. Examined	31	38	92	23	11	6	23	34	21	9	32	18
Umbilical Hernia					Percent Prevalence							
Grade I	16.1	13.2	10.9		36.4		21.7	20.6	9.5	22.2	21.9	11.1
Grade II	3.2	10.5	5.4		9.1		21.7	17.6	9.5	11.1	15.6	5.6
Grade III			1.1					2.9				
Grade not stated		7.9	8.7	26.1							3.1	
Yellow Palms												
No. Examined	32	37	33	-	11	6	24	34	21	9	34	20
Grade I	9.4	21.6	36.4		72.7	50.0	29.2	32.4	14.3	33.3	41.2	40.0
Grade II	3.1	13.5					16.7	5.9	4.8	11.1	14.7	15.0
Grade III									4.8		2.9	
Grade not stated	3.1	2.7	60.6						4.8		2.9	

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TABLE 73. CLINICAL FINDINGS BY AGE AND BY SEX, PEDIATRIC SAMPLE, NIGERIA

Age	Months		Years				Sex		
	0-5	6-11	1	2	3	4	Males	Females	Total
Recent History									
No. Reported	24	63	55	23	58	48	139	132	271
Diarrhea			Percent Prevalence						
Current		4.8	14.5	8.7	15.5	8.3	9.4	9.8	9.6
Recent	4.2	17.5	14.5	13.0	5.2	6.2	12.9	8.3	10.7
Recurrent		4.8	14.5	4.3	19.0	14.6	10.8	11.4	11.1
Respiratory Disease									
Current	33.3	31.7	27.3	8.7	15.5	27.1	25.9	23.5	24.7
Recent	16.7	9.5	10.9	8.7	8.6	10.4	8.6	12.1	10.3
Recurrent	4.2	9.5	7.3	4.3	12.1	12.5	9.4	9.1	9.2
Other									
Pica			1.8		1.7		1.4		0.7
Parasites		1.6	1.8		3.4	6.2	2.2	3.0	2.6
Malaria	33.3	25.4	34.5	13.0	24.1	22.9	29.5	22.7	26.2
Fever	33.3	20.6	21.8	17.4	31.0	43.7	29.5	26.5	28.0
Cough	20.8	19.0	9.1		1.7	8.3	5.8	14.4	10.0
Boils		4.8	10.9	13.0	1.7		4.3	5.3	4.8
No. Examined	43	88	91	48	85	77	218	214	432
General Impression			Percent Prevalence						
Apathy		8.0	8.8	6.2	4.1	10.4	6.9	7.0	6.9
Pallor	7.0	8.0	3.3	2.1			2.3	4.2	3.2
Irritability		11.4	12.1	2.1	4.7		5.0	7.0	6.0
Clinical Impression									
Marasmus	2.3	1.1	2.2	4.2	1.2		1.4	1.8	1.6
Prekwashiorkor			1.1		1.2			1.4	0.7
Kwashiorkor		1.1	2.2				1.4	0.5	0.9
Good	41.8	48.8	18.7	22.9	17.6		22.5	31.3	26.8
Fair			2.2				0.9	0.5	0.7
Poor			1.1	4.2	1.2		1.3	0.9	1.1
Unspecified	58.1	51.1	78.0	72.9	81.2		75.2	67.3	71.3
Hair									
Dry staring	2.3	2.3	3.3	4.2		1.3	1.8	2.3	2.1
Dyspigmentation		3.4	6.6	2.1	1.2	2.6	3.2	2.8	3.0
Thin	2.3	1.1	2.2				0.9	0.9	0.9
Easily pluckable		2.3	2.2	6.2	1.2	1.3	2.3	1.9	2.1

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TABLE 73. (Continued). CLINICAL FINDINGS BY AGE AND BY SEX, PEDIATRIC SAMPLE, NIGERIA

	Months		Years				Sex		
Age	0-5	6-11	1	2	3	4	Males	Females	Total
No. Examined	43	88	91	48	85	77	218	214	432
Eyes									
Conjunctivitis			1.1		1.2		0.5	0.5	0.5
Lips									
Angular lesions			1.1	2.1	4.7	9.1	3.2	2.8	3.0
Cheilosis		2.3	1.1	4.2	2.4	3.9	1.8	2.8	2.3
Gums									
Swollen red papillae -diffuse			2.2	10.4	11.8	10.4	6.4	5.1	5.8
Bleeding			1.1	6.2	5.9	5.2	2.8	3.3	3.0
Tongue									
Filiform papillary atrophy - mild		2.3			2.4	1.3	2.3		1.2
-moderate				2.1			0.9		0.5
Glossitis		1.1	1.1			1.3	0.5	0.9	0.7
Thyroid Enlarged									
Grade I				1.1	4.2	7.1	3.2	4.7	3.9
Grade II						1.2		0.5	0.2
Grade not stated					2.1	2.4	0.9	0.5	0.7
Skin									
Inelastic			1.1			1.2		0.9	0.5
Dermatitis			1.1	1.1	2.1	3.5	2.3	2.3	2.3
Abdomen									
Hepatomegaly		32.6	50.0	35.2	64.6	51.8	46.3	47.2	46.8
Splenomegaly		25.6	27.3	31.9	41.7	31.8	32.1	30.8	31.5
Potbelly			5.7	2.2	6.2	10.6	6.0	5.1	5.6
Lower Extremities									
Bilateral edema				2.2	2.1	2.4		2.8	1.4
Skeletal									
Costochondral beading			2.3	3.3	2.1	3.5	2.3	2.3	2.3
Enlarged joints							0.5		0.2
Muscle wasting			4.5	5.5	2.1	3.5	2.8	3.7	3.2
Umbilical Hernia									
No. Examined	41	85	85	46	78	75	208	202	4.0
Grade I	17.1	20.0	16.5	10.9	15.4	14.7	15.9	16.3	16.1
Grade II	14.6	4.7	14.1	17.4	7.7	10.7	10.6	10.9	10.7
Grade III		1.2		2.2				1.0	0.5
Grade not stated	7.3	1.2	7.1	10.9	2.6	2.7	4.8	4.5	4.6

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TABLE 73.(Continued). CLINICAL FINDINGS BY AGE AND BY SEX, PEDIATRIC SAMPLE, NIGERIA

Age	Months		Years				Sex		
	0-5	6-11	1	2	3	4	Males	Females	Total
Yellow Palms									
No. Examined	32	72	66	43	64	58	172	163	335
Grade I	3.1	1.4	21.2	27.9	46.9	44.8	23.8	26.4	25.1
Grade II			3.0	11.6	14.1	15.5	9.3	5.5	7.5
Grade III			1.5			1.7	0.6	0.6	0.6
Grade not stated		1.4	4.5		12.5	20.7	8.1	6.1	7.2

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TABLE 74. CLINICAL FINDINGS BY REGION, PEDIATRIC SAMPLE, NIGERIA

Region	Derived Savannah	Savannah	Plateau	Lagos	Rain Forest	Coastal
Recent History						
No. Reported	59	5	43	38	82	44
			Percent Prevalence			
Diarrhea						
Current	3.4		7.0	15.8	9.8	15.9
Recent	3.4	20.0	16.3	15.8	12.2	6.8
Recurrent	3.4		11.6	15.8	19.5	2.3
Respiratory Disease						
Current	16.9		27.9	36.8	25.6	22.7
Recent	1.7		30.2	13.2	6.1	9.1
Recurrent			4.7	34.2	12.2	
Other						
Pica					2.4	
Parasites				2.6		13.6
Malaria	39.0	20.6	39.5		30.5	13.6
Fever	20.3	40.0	4.7	2.6	63.4	15.9
Cough	15.3		4.7	5.3	15.9	2.3
Boils	6.8			21.1	1.2	
No. Examined	79	22	55	72	141	63
General Impressions						
Apathy	7.6	13.6	5.5	4.2	7.1	7.9
Pallor	10.1		3.6		2.8	
Irritability	10.1	13.6	3.6	5.6	6.4	
Clinical Impression						
Marasmus	5.1	13.6				
Prekwashiorkor	1.3	4.5				1.6
Kwashiorkor		9.1	1.8			1.6
Good	37.9	9.1	25.4	44.4	12.0	33.3
Fair	1.3	4.5			0.7	
Poor				1.4	2.1	1.6
Unspecified	60.8	86.4	74.5	54.1	85.1	65.1
Hair						
Dry staring			14.5	1.4		2.1
Dyspigmentation		18.2	12.7	1.4	0.7	3.0
Thin			3.6	1.4	0.7	0.9
Easily pluckable			9.1	4.2	0.7	2.1
Eyes						
Conjunctivitis				1.4	0.7	
Lips						
Angular lesions	1.3			2.8	4.3	6.3
Cheilosis			16.4		0.7	

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TABLE 74. (Continued). CLINICAL FINDINGS BY REGION, PEDIATRIC SAMPLE, NIGERIA

Region	Derived Savannah	Savannah	Plateau	Lagos	Rain Forest	Coastal
No. Examined	79	22	55	72	141	63
Gums						
Swollen red papillae -diffuse	6.3	18.2			9.2	4.8
Bleeding	5.1	9.1			2.8	4.8
Tongue						
Filiform papillary atrophy - mild	1.3		3.6	1.4	0.7	
- moderate	1.3			1.4		
Glossitis	1.3	4.5			0.7	
Thyroid Enlarged						
Grade I	7.6			11.1	1.4	1.6
Grade II				1.4		
Skin						
Inelastic	1.3			1.4		
Dermatitis	1.3	4.5	12.7	1.4		
Abdomen						
Hepatomegaly	78.5	68.2	40.0	36.1	31.9	50.8
Splenomegaly	63.3	72.7	30.9	1.4	22.7	31.7
Potbelly	2.5		3.6	4.2	7.8	9.5
Lower Extremities						
Bilateral edema	2.5	9.1			0.7	1.6
Skeletal						
Costochondral beading	2.5			2.8	3.5	1.6
Enlarged joints						1.6
Muscle wasting	3.8		3.6		5.0	3.2
Umbilical Hernia						
No. Examined	78	19	53	69	132	59
Grade I	17.9	15.8	26.4	14.5	10.6	18.6
Grade II	16.7	15.8	18.9	7.2	4.5	11.9
Grade III	1.3				0.8	
Grade not stated			1.9	47.8	10.6	1.7
Yellow Palms						
Grade I	26.6	10.5	3.6	15.9	46.0	39.7
Grade II	8.9	10.5	1.8	8.7		14.3
Grade III	1.3					1.5
Grade not stated	1.3			2.9	40.0	1.5

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Clinical Symptoms

The incidence of changes in the hair, eye disease, angular lesions, cheilosis, gum and tongue pathology, skin lesions, and changes in the bones as manifestations of nutritional deficiency diseases was extremely low in most regions (except Zaria in the Savannah), and requires no further comment.

Only one case of possible scurvy was seen during the survey and this was not substantiated by serum vitamin C determination. Costochondral beading was seen in only 2 percent of all patients, and frank vitamin D deficiency rickets was not encountered.

The high incidence of changes in hair and lips in the Plateau area was felt to be due to both examiner differences and the hot dry climate.

Thyroid Enlargement

Thyroid enlargement was seen infrequently in the pediatric group (Table 78), 3.9 percent. The incidence was highest in the Derived Savannah area (7.6 percent) and the urban Federal District of Lagos (11.1 percent). The reason for the latter is unclear and may represent local feeding practices. A separate study of the thyroid was carried out in the Plateau region (see Table 80). No cases of cretinism or hypothyroidism were recognized in the pediatric age group.

Hepatomegaly

In North American children the liver is normally palpable about 1--2 cm below the costal margin in the right midclavicular line, during the age period 0--4 years. It is our impression that in Nigerian children there is an increased lordosis which results in the liver being more "uncovered," and that a liver palpable 3--4 cm below the costal margin does not necessarily represent abnormality.

Similarly, the "pot belly" seen almost universally in Nigerian children, does not in itself indicate disease or malnutrition, but must be considered in conjunction with other physical signs and symptoms.

However, the incidence of hepatomegaly (i.e. liver palpable more than 2 cm below the costal margin) roughly parallels the incidence of splenomegaly, except in the Federal District (Lagos) where splenomegaly was virtually absent, and hepatomegaly occurred in 36 percent.

Splenomegaly

Splenomegaly was a constant finding in 25--30 percent of children of all ages and in all regions except Lagos (1.4 percent), the Derived Savannah (63 percent), and the Savannah (72 percent). As mentioned

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previously, malaria appeared to be relatively uncommon in the Federal District and extremely prevalent in the Derived Savannah (39 percent) and the Savannah. In the latter, because of lack of personnel and time, histories were not documented. However, it was in an outlying rural area of this region that the highest incidences of disease, marasmus, and protein-calorie malnutrition were seen.

The incidence of very large spleens (more than 4 cm below the costal margin) appeared to increase until about age 2 years, and then decrease, possibly reflecting acquisition of immunity.

Yellow Palms

Yellow palms occurred infrequently below age 18 months (9.3 percent) and then with increasing frequency until age 4 years, when they were observed in 92.7 percent of the children examined (see Table 73).

The absence of yellow palms does not mean vitamin A deficiency; the presence of yellow palms probably precludes such a diagnosis and may be a useful screening test.

Infant Mortality

As mentioned previously, obstetric histories were often quite unreliable. However, it is felt that the following figures regarding mortality in liveborn infants occurring during the age period 0 through 4 years represent a conservative estimate.

TABLE ADDENDA 2. INFANT MORTALITY BY REGIONS

Source of Data	Urban	Rural	Infant Welfare Clinic	Dependents of Military Personnel	Average
		Percent Mortality			
Derived Savannah (Ilorin, Nsukka)		27.4	4		19.6
Savannah (Zaria)	No figures available - - - - - - - - - - - - - - - - - -				
Plateau (Jos)		45.6	26		35.8
Federal District (Lagos)			22.7		22.7
Rain Forest (Ibadan, Asaba)		26.3		16.9	21.6
Coastal (Epe, Port Harcourt)	13		17.4		13.7
Country Average					22.7

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Nutritional Status, Growth, and Development

Although frank kwashiorkor and marasmus were rarely seen outside of hospitals and out-patient clinics, it was apparent that mild and moderate degrees of protein-calorie malnutrition, reflected only by inadequate growth and development, were the rule (see Figures 4 and 5).

At birth, weight and height of Nigerian infants approach North American and European averages. The infants thrive for the first few months, this period coinciding with the period of optimal breast feeding. Beginning at about 3 months of age, more and more infant weights slip below the 16th percentile of the Iowa growth grids for U.S. children. This trend continues throughout the preschool years (Figures 4 and 5). The lag in average height appears about 2--3 months later than the lag in weight, falling below the 16th percentile at about 6--8 months of age, and paralleling this curve at a lower level throughout the next 4 1/2 years.

Regional variations occur, possibly related in part to genetic factors, Hausas and Fulanis in the northern regions being taller than Yorubas and Ibos in the south and east. There appears as well to be a definite improvement in height and weight in children from higher socioeconomic groups (Port Harcourt, dependents of military personnel), and in areas where health services are more adequate. All of these observations confirm the results of many longitudinal studies which have been made previously in Nigeria.

The relative importance of infection and protein-calorie undernutrition in their effects on growth are difficult to assess and would appear to run hand in hand. These and other disease and socioeconomic influences are considered by Rhea in his studies in the Lagos area. Genetic factors appeared to be of much less importance than environmental ones.

The return toward normal heights and weights in children 4 years old and above which is seen in some countries was not observed in Nigeria (1). In urban areas such as Lagos, fewer children fell as far below the 16th percentile as in predominantly rural areas.

In certain relatively isolated and unorganized regions such as Makarfi village near Zaria, severe protein-calorie malnutrition (frank kwashiorkor) and marasmus were much in evidence, although frank vitamin deficiencies were not seen. In certain regions anemia seemed more prevalent, but again it was impossible to assess the relative importance of disease (malaria, sickle cell anemia, infestation with parasites) and nutritional deficiency.

There was no striking difference in the incidence of malnutrition between boys and girls.

It is apparent then that from about 6 months of age until school age, dietary inadequacies are greatest and infections are prevalent.

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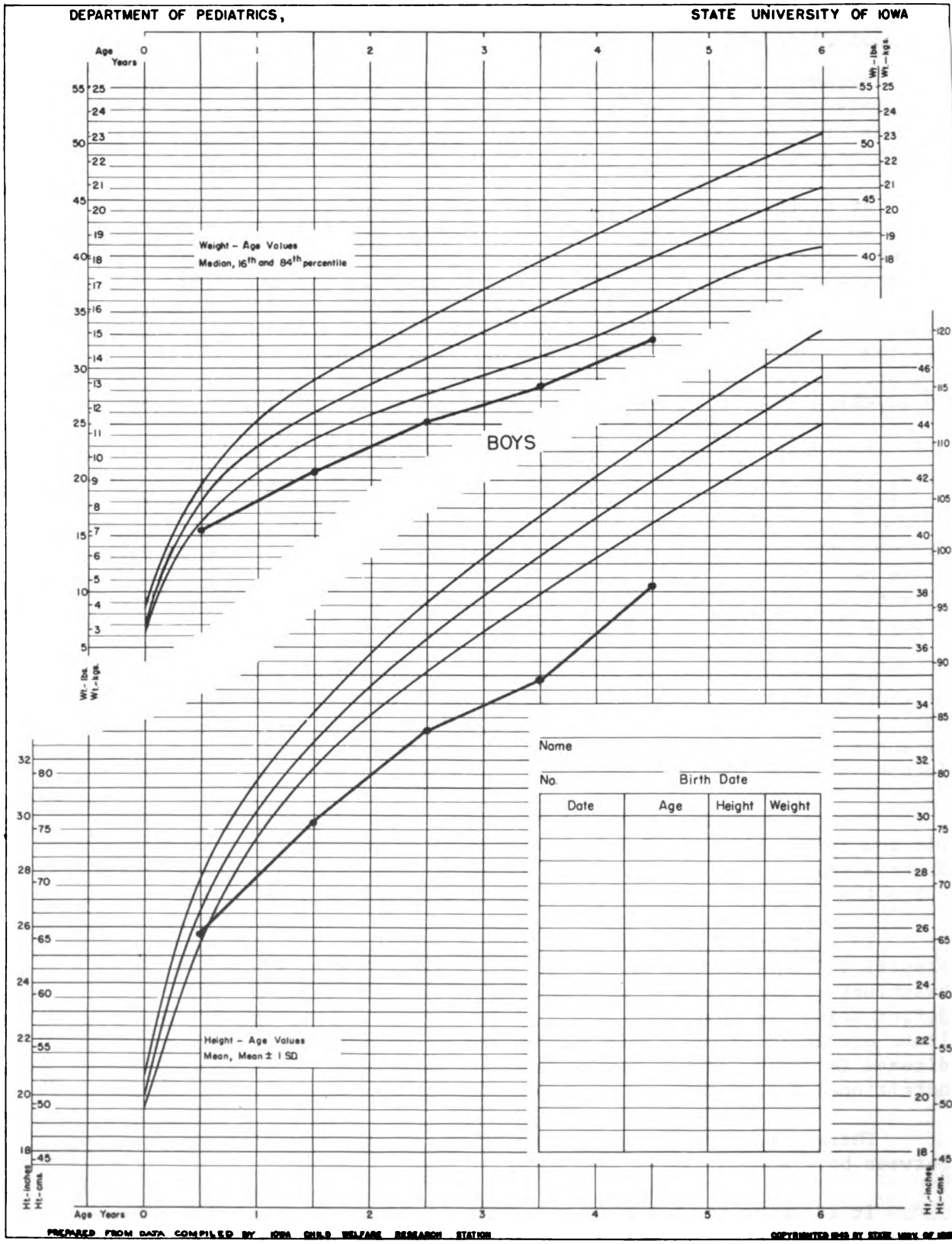

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FIGURE 4. MEAN WEIGHTS AND HEIGHTS OF NIGERIAN BOYS 0-4 YEARS OF AGE

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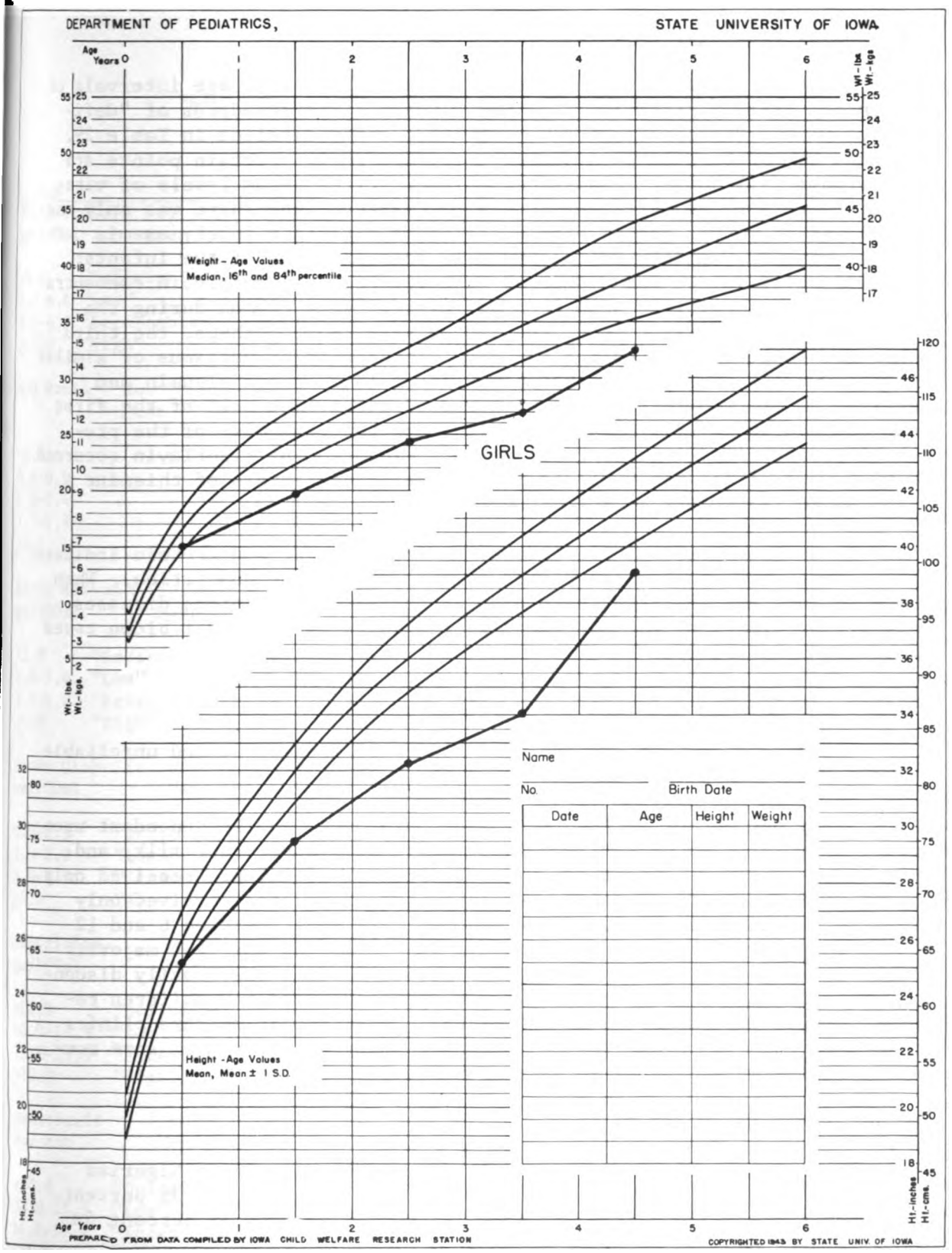

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FIGURE 5. MEAN WEIGHTS AND HEIGHTS OF NIGERIAN GIRLS 0–4 YEARS OF AGE

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Biochemical Findings, 0--4 Year Age Group

Table 75 presents the biochemical findings for the age intervals of <6 months, 6--11 months, 1, 2, 3, and 4 years. The standards of "deficient," "low," "acceptable," and "high" are those detailed in Table 29. Although the numbers in each age category are small, certain points are noteworthy: all subjects had acceptable or better serum levels of vitamin C; there were no deficient levels of carotene, and there was only one infant (6--11 months group) with a deficient vitamin A level; anemia (hemoglobin <10.0 gm/100 ml) occurred in some 1/3--2/3 of the infants; low hematocrit values and subnormal mean corpuscular hemoglobin concentrations (MCHC), consistent with iron deficiency, were common during the second half of the first year, the second year, and, perhaps, the third year. By contrast, except for the exceptional case of marasmus or similar condition noted during the first 6 months of life, serum albumin and total serum protein levels were higher during the last half of the first year and continued at similar levels through the remainder of the preschool years. After one year of age, "low" excretion of riboflavin occurred in up to 2/3 of the infants, and "low" and "deficient" levels of thiamine occurred in 1/3 to 1/2 of the infants.

These low levels of riboflavin, thiamine, iron, and protein indicate that a large number of malnourished infants are in the population. When these infants are subjected to the added burden of infectious diseases, malaria, or diarrhea, they are readily precipitated into full blown cases of severe malnutrition.

Dietary and Feeding Patterns

Although dietary histories were generally inadequate and unreliable, certain trends were apparent.

Sixty percent of infants age 0--5 months were wholly dependent upon breast milk, 31 percent received breast milk plus some other milk, and only a few received other foods. Twenty percent of infants received only breast milk during the first year of life and 15 percent received only breast milk and other milk. "Other foods" were added between 6 and 12 months for 42 percent; it was not until 12--18 months that the majority of the infants had other foods added. Breast feeding was usually discontinued beginning at 12 months of age (40 percent), and few children received breast milk after 18 months of age. Most infant welfare clinics instructed mothers to discontinue breast feeding at 12 months; some routinely supplemented breast feeding from age 4 months on.

Umbilical Hernia

Umbilical hernia (see Table 73) is extremely common in Nigerian children. Over-all incidence in the pediatric age group was 39 percent. There was a gradually decreasing prevalence ranging from 39 percent in

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TABLE 75. BIOCHEMICAL LEVELS OF NUTRIENTS BY AGE IN CHILDREN 0-4 YEARS, NIGERIA

Age		<6 month	6-11 months	1 year	2 years	3 years	4 years	Total
Total Protein	No.	7	23	18	11	11	15	85
gm/100ml	Mean	6.07	6.91	6.96	6.95	6.62	6.88	6.81
				Percent Distribution				
<6.0	"Deficient"	28.6	-	-	9.1	27.3	6.7	8.2
6.0-6.4	"Low"	57.1	21.7	22.2	9.1	9.1	6.7	18.8
6.5-6.9	"Acceptable"	14.3	21.7	22.2	27.3	18.2	40.0	24.7
≥7.0	"High"	-	56.5	55.6	54.5	45.5	46.7	48.2
A/G Ratio	No.	7	23	18	11	11	15	85
	Mean	1.32	1.17	1.09	1.06	0.94	1.08	1.10
				Percent Distribution				
<0.5		-	4.3	-	-	9.1	-	2.4
0.5-0.9		28.6	21.7	38.9	45.5	54.5	53.3	38.8
1.0-1.4		42.9	56.5	50.0	45.5	27.3	26.7	43.5
1.5-1.9		14.3	17.4	11.1	-	9.1	20.0	12.9
≥2.0		14.3	-	-	9.1	-	-	2.4
Serum Albumin	No.	7	23	18	11	11	15	85
gm/100ml	Mean	3.50	3.65	3.54	3.48	3.08	3.46	3.49
				Percent Distribution				
<2.8	"Deficient"	-	4.3	5.6	18.2	-	7.1	
2.8-3.4	"Low"	42.9	17.4	33.3	27.3	54.5	60.0	36.5
3.5-4.2	"Acceptable"	57.1	78.3	55.6	45.5	27.3	40.0	54.1
≥4.3	"High"	-	-	5.6	9.1	-	-	2.4
Serum Globulin	No.	7	23	18	11	12	15	86
gm/100ml	Mean	2.57	3.27	3.41	3.46	3.49	3.40	3.32
				Percent Distribution				
1.0-1.9	"Deficient"	14.3	-	-	-	-	-	1.2
2.0-2.9	"Low"	71.4	43.5	22.2	36.4	33.3	20.0	34.9
3.0-3.5	"Acceptable"	14.3	34.8	44.4	18.2	33.3	40.0	33.7
≥3.5	"High"	-	21.7	33.3	45.5	33.3	40.0	30.2
Hemoglobin	No.	7	23	18	12	14	16	90
gm/100ml	Mean	62	195	163	112	145	164	841
				Percent Distribution				
<10.0	"Deficient"	85.7	69.6	44.4	41.7	21.4	31.2	47.8
10.0-10.9	"Low"	14.3	26.1	44 .4	41.7	35.7	25.0	32.2
11.0-11.9	"Acceptable"	-	-	11.1	8.3	35.7	25.0	13.3
≥12.0	"High"	-	4.3	-	8.3	7.1	18.8	6.7
Hematocrit	No.	6	23	17	11	14	16	87
Percent	Mean	31.8	31.7	33.8	33.5	33.4	33.8	33.0
				Percent Distribution				
<30.0	"Deficient"	16.7	34.8	11.8	18.2	14.3	12.5	19.5
30.0-33.9	"Low"	66.7	30.4	11.8	27.3	35.7	31.2	29.9
34.0-36.9	"Acceptable"	16.7	13.0	52.9	27.3	35.7	37.5	31.0
≥37.0	"High"	-	21.7	23.5	27.3	14.3	18.8	19.5

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TABLE 75. BIOCHEMICALS LEVELS OF NUTRIENTS BY AGE IN CHILDREN 0-4 YEARS, NIGERIA (continued)

Age		<6 months	6-11 months	1 year	2 years	3 years	4 years	Total
Mean Corpuscular Hemoglobin Concentration	No.	6	23	17	11	14	16	87
Percent	Mean	29.6	28.2	28.6	30.4	32.4	31.7	30.0
				Percent Distribution				
<28.0		16.7	30.4	29.4	9.1	-	-	16.1
28.0-29.9		50.0	43.5	52.9	36.4	21.4	18.8	36.8
30.0-31.9		16.7	21.7	17.6	36.4	28.6	37.5	26.4
≥32.0		16.7	4.3	-	18.2	50.0	43.8	20.7
Serum Vitamin C	No.	7	23	18	11	12	14	85
gm/100ml	Mean	2.63	2.80	2.32	1.71	1.07	1.22	2.04
				Percent Distribution				
<.10	"Deficient"	-	-	-	-	-	-	-
.10-.19	"Low"	-	-	-	-	-	-	-
.20-.39	"Acceptable"	-	-	-	9.1	8.3	14.3	4.7
≥.40	"High"	100.0	100.0	100.0	90.9	91.7	85.7	95.3
Serum Vitamin A	No.	7	22	14	11	9	10	73
µg/100ml	Mean	19	67	33	28	25	26	198
				Percent Distribution				
<10	"Deficient"	-	4.5	-	-	-	-	1.4
10-19	"Low"	-	4.5	21.4	9.1	11.1	20.0	11.0
20-49	"Acceptable"	100.0	81.8	78.6	90.9	77.8	80.0	83.6
≥50	"High"	-	9.1	-	-	11.1	-	4.1
Serum Carotene	No.	7	22	14	11	9	10	73
µg/100ml	Mean	72	18	87	150	144	158	115
<20	"Deficient"	-	-	-	-	-	-	-
20-39	"Low"	-	9.1	28.6	9.1	11.1	10.0	12.3
40-99	"Acceptable"	71.4	63.6	28.6	18.2	22.2	10.0	38.4
≥100	"High"	28.6	27.3	42.9	72.7	66.7	80.0	49.3
Serum Cholesterol	No.	7	23	17	11	11	15	84
mg/100ml	Mean	126	29	126	114	143	146	141
				Percent Distribution				
70-99		28.6	-	5.9	45.5	-	20.0	13.1
100-149		57.1	47.8	82.4	36.4	72.7	33.3	54.8
150-199		14.3	34.8	11.8	18.2	27.3	40.0	26.2
≥200		-	17.4	-	-	-	6.7	6.0
Thiamine Excretion	No.	6	20	13	7	8	6	49
µg/gm	Median	00	300	415	742	1,610	648	645
Creatinine				Percent Distribution				
	"Deficient"	100.0	33.3	-	-	-	5.0	6.1
	"Low"	-	-	20.0	-	-	5.0	4.1
	"Acceptable"	-	33.3	60.0	33.3	28.6	20.0	28.6

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TABLE 75. BIOCHEMICAL LEVELS OF NUTRIENTS BY AGE IN CHILDREN 0-4 YEARS, NIGERIA (continued)

Age		<6 months	6-11 months	1 year	2 years	3 years	4 years	Total
Riboflavin Excretion								
No.		4	15	12	6	6	6	49
Median µg/gm Creatinine		500	542	144	71	189	146	168
				Percent Distribution				
	"Deficient"	-	-	66.7	71.4	31.2	35.0	35.0
	"Low"	33.3	37.5	33.3	28.6	56.2	45.0	43.3
	"Acceptable"	33.3	25.0	-	-	6.2	10.0	10.0
	"High"	33.3	37.5	-	-	6.2	10.0	11.7
N -Methylnicotinamide								
No.		4	15	12	7	6	5	49
Median mg/gm Creatinine		40.0	3.7	13.1	8.6	6.2	5.2	6.4
				Percent Distribution				
<0.5	"Deficient"	-	-	-	-	6.2	4.8	3.3
0.5-1.59	"Low"	-	25.0	-	-	6.2	-	5.0
1.6-4.29	"Acceptable"	-	37.5	-	-	12.5	38.1	21.7
≥4.3	"High"	100.0	37.5	100.0	100.0	75.0	57.1	70.0

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infants under 6 months to approximately 25 percent in 3 and 4 year olds. In the 5--14 year age group, the prevalence had fallen to 15 percent. Only one incarcerated hernia was seen. The incidence was as high in babies attending infant welfare clinics, many of whom had been born in hospitals where cord tying procedures are similar to those practiced in the U.S.A.

Oral Hygiene (see also Chapter X)

Dental caries were rarely seen in the pediatric age group, although in most regions diffuse gingival disease, with calculus formation, bleeding gums, and gum recession occurred in 5--10 percent. Isolated villages (Makarfi near Zaria) showed a much higher incidence of more severe gingival disease.

Clinical Findings in Children Above Age Five and in Adults

The composition of the survey sample which was five years or more of age is recorded in Table 76. Included was a total of 4,201 individuals in six regions. Of this number 1,971 were civilian males and 1,167 nonpregnant, nonlactating females. In addition, there were 676 military personnel, 130 police, and 257 pregnant or lactating women. The distribution by region, age, and sex is presented in the table.

Body weight and height were recorded on all individuals. Body weight was determined without shoes in usual clothing, which was light in this tropical area. The height was recorded without shoes. Mean weight and height for boys of 5 to 17 years is shown in Figure 6 where a comparison is made with growth standards for North American boys. Similar observations are presented for Nigerian girls in Figure 7.

These data indicate that the growth curve for Nigerian boys and girls parallels, but at a lower level, that of North American children, their heights after age 8 years falling below that of the lowest 16th percentile of boys and girls in North America, and at any given age their weight falling below that of the median percentile.

The obvious increase in the height and weight of boys and girls to values close to the median percentile by North American standards during the ages of 7 and 8 is difficult to explain, but may be related to the influence of the widespread use of school lunch programs. Nevertheless, between the ages of 8 and 13, when the growth acceleration of adolescence is usually apparent, the weight of girls is just above the lowest 16th percentile and that of boys is just below the lowest 16th percentile for North American children. The heights of boys and girls between ages 8 and 13 follows a similar growth trend. It would seem justified to conclude that there is significant potential for improved growth, particularly after age 8. A more detailed examination of growth curves for boys and girls from each region (see appendex 16) indicates that the children from the Urban Federal District and the Savannah regions have growth curves closest to the median percentile of North American children, while the children from the Rain

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TABLE 76 AGE AND SEX DISTRIBUTION BY REGION, CLINICAL SAMPLE, NIGERIA

Location	Males Age (years) 5-14	15+	Total	Females Age (years) 5-14	15+	Total
Derived Savannah	173	301	474	72	102	174
Savannah	149	179	328	44	7	51
Plateau	92	22	114	48	20	68
Urban Federal District	221	32	253	202	19	221
Rain Forest	193	147	340	253	169	422
Coastal	241	221	462	132	99	231
Total	1,069	902	1,971	751	416	1,167
Percent	54.2	45.8		64.4	35.6	
Military		676				
Police		130				
Pregnant and Lactating Women					257	

Grand Totals
Male 2,777
Female 1,424
Total 4,201
+ Pediatrics

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FIGURE 6.
MEAN WEIGHTS AND HEIGHTS OF NIGERIAN BOYS 5-17 YEARS OF AGE COMPARED WITH THOSE OF NORTH AMERICAN BOYS (Numbers in parentheses = number of individuals of that age measured).

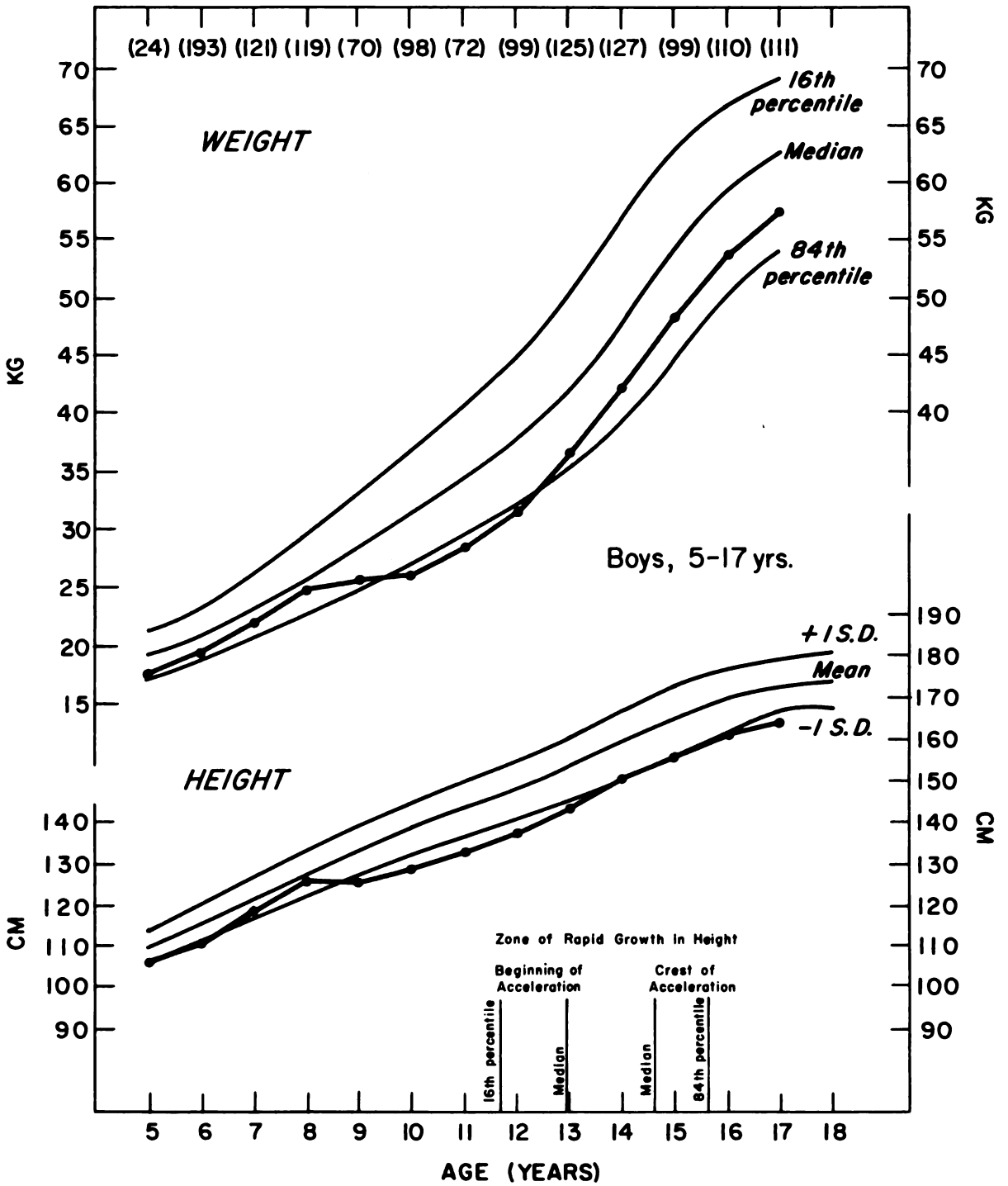

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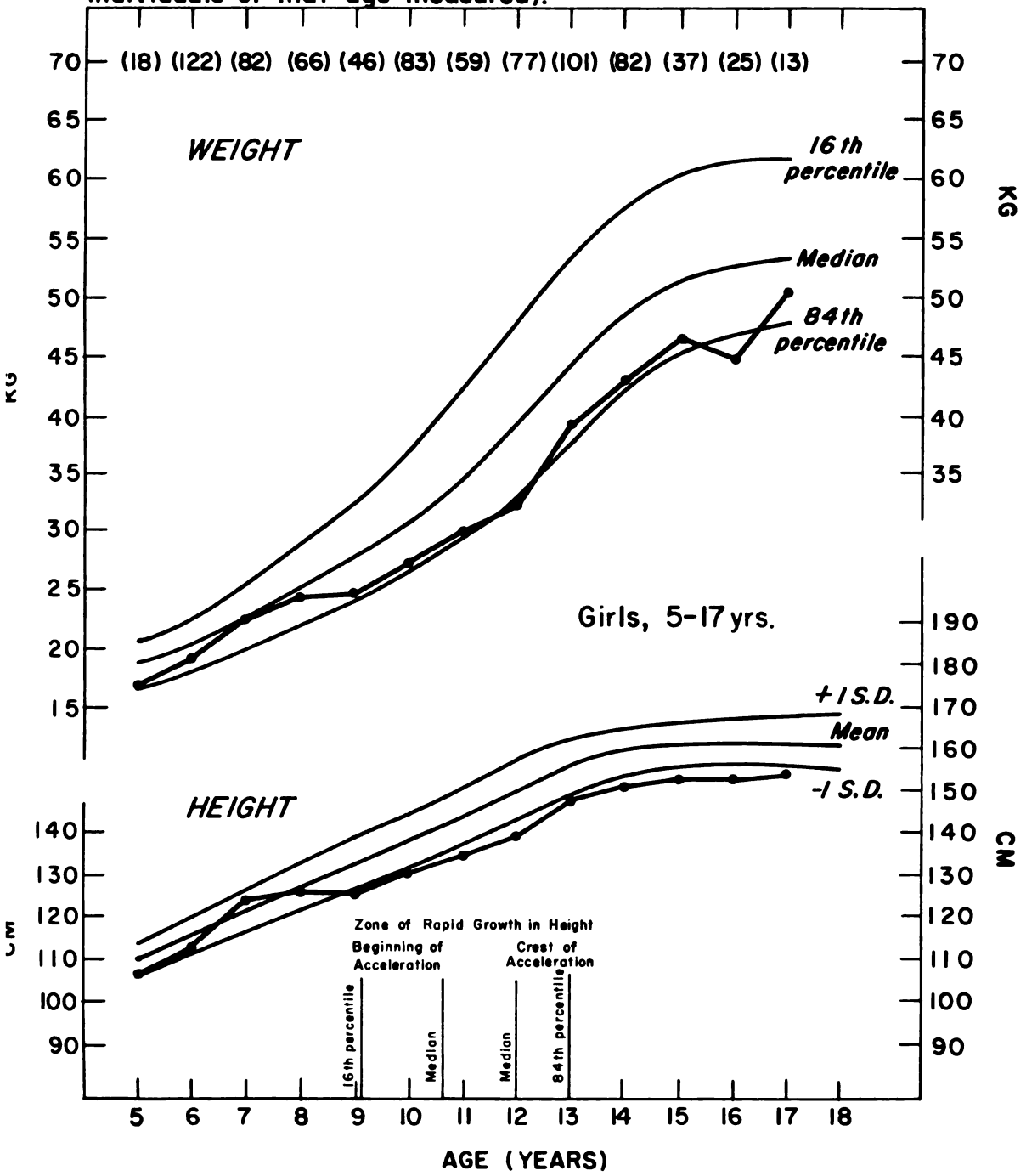
FIGURE 7.

MEAN WEIGHTS AND HEIGHTS OF NIGERIAN GIRLS 5-17 YEARS OF AGE COMPARED WITH THOSE OF NORTH AMERICAN GIRLS (Numbers in parentheses = number of individuals of that age measured).



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Forest and Coastal regions are most retarded in growth, especially after age 8. From the parasitologic study (Table 66) these geographic differences in growth may be related to the prevalence of malaria infections as well as to dietary differences (Table 23).

The average weights of men and women at maturation and by a decade of age in adulthood in Nigeria are plotted in Figure 8. The average weight by age of North Americans of a body height approximating that of the average Nigerian man and woman in the survey is presented for comparison. While the weight of North American men and women increases steadily throughout most of adulthood, that of the Nigerian men and women changes little once adulthood is reached. The implication is drawn that the adult population of Nigeria is less likely to become obese with advancing years than are North Americans, and is consistent with the results of the skin-fold measurements. For the average Nigerian male and female there is an increase in body weight of 12.5 kg and 6.0 kg, respectively, between ages 15 and 22 years, an increment which is twice as great as that of the average North American male and female between the same ages. This difference may be the effect of a delayed adolescent growth acceleration.

Other descriptions of the survey sample are included in Table 77 which lists the number of persons 15 years or above, of each sex in each region, and records the mean age, height, weight, and percent of "standard weight." Percent of "standard weight" was estimated by reference to North American standard tables (2). The effects of retarded growth among children 5 to 14 years seem to be reflected in the data on adults presented in Table 77 . The lowest heights among men and women were recorded in the Plateau and Coastal regions. The lowest weights were recorded among men in the Plateau and Coastal regions and among women in the Plateau and Rain Forest region. For the entire sample, women were of greater percent "standard weight" than men, mean values being 97.6 and 93.2 percent, respectively.

This difference is better understood in the measurements of skinfold thickness over the triceps of the upper arm and the angle of the scapula as a means of estimating body stores of subcutaneous fat. The mean values for skinfold thickness at these selected sites are recorded for males and females in terms of age in Figure 9 and in terms of percent "standard weight" in Figure 10. These figures demonstrate a rather lean population with larger quantities of subcutaneous fat in females than in males at all ages, but particularly during the child-bearing years. The results presented in Figure 10 indicate that, as adults exceed 100 percent of "standard weight," the women tend to accumulate subcutaneous fat while the men increase their muscle mass as well as subcutaneous fat.

Clinical observations in the abbreviated examination are summarized in terms of prevalence in various age groups (Table 78) and in the six survey regions (Table 79). Although the general appearance of subnutrition

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TABLE 77. MEAN AGE, HEIGHT, WEIGHT AND PERCENT "STANDARD WEIGHT" BY SEX AND LOCATION, INDIVIDUALS 15 YEARS AND ABOVE, NIGERIA

	Male					Female				
Location	Number	Age 1/ (years)	Height (cm)	Weight (kg)	Percent "Standard Weight" 2/	Number	Age (years)	Height (cm)	Weight (kg)	Percent "Standard Weight"
Derived Savannah	300	21	166	59.2	93.1	101	28	156	51.7	96.3
Savannah	179	17	164	57.9	95.3	7	26	155	60.3	117.5
Plateau	22	22	163	56.4	91.6	20	27	152	49.9	97.8
Urban Federal District	30	32	168	61.1	93.6	18	26	158	58.1	110.7
Rain Forest	146	30	167	58.3	91.1	163	25	157	50.9	94.8
Coastal	217	24	163	56.2	93.2	98	30	155	53.1	99.9

1/ Mean age of individuals between 15 and 44 years.

2/ Calculated for group above age 17 years.

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TABLE 78. CLINICAL FINDINGS BY SEX AND AGE, ABBREVIATED EXAMINATIONS, NIGERIA

Sex	Males						Females					
Age (years)	5-14	15-24	25-34	35-44	45+	Total	5-14	15-24	25-34	35-44	45+	Total
Total Number	1,069	526	143	88	145	1,973	751	133	135	56	92	1,167
						Percent Prevalence						
Skin												
Nasolabial seborrhea	1.2	13.3	11.2	4.5	6.9	5.7	1.5	1.5	5.2	3.6	4.3	2.2
Follicular hyperkeratosis	0.2	1.0	2.1	3.4	4.8	1.0	0.3	0.0	0.8	0.8	0.0	0.3
Yellow palms-slight	36.1	37.4	39.0	33.9	40.7	36.9	34.9	50.9	43.1	39.5	34.3	37.0
-moderate to severe	35.5	46.4	41.4	35.7	31.3	38.9	29.5	31.6	37.5	48.8	43.3	32.5
Lips												
Angular lesions	4.1	1.1	0.7	2.3	4.8	3.0	2.5	3.0	2.2	3.6	4.3	2.7
Angular scars	6.1	3.4	5.6	8.0	11.7	5.8	5.7	3.8	11.9	12.5	7.6	6.7
Cheilosis-slight	1.3	1.5	0.7	0.0	0.0	1.2	1.1	0.0	0.0	0.0	0.0	0.7
-moderate to marked	0.7	0.0	0.0	0.0	0.0	0.4	0.1	0.8	0.7	0.0	0.0	0.3
Gums												
Swollen red papillae												
-localized	6.5	3.6	9.1	10.2	16.6	6.8	6.1	6.0	10.4	12.5	14.1	7.5
-diffuse	3.7	4.0	4.9	12.5	6.2	4.5	2.0	3.0	2.2	7.1	10.9	3.1
Tongue												
Filiform papillary atrophy												
-slight	3.2	1.0	7.0	4.5	5.5	3.1	3.2	2.3	6.7	12.5	8.7	4.4
-moderate to severe	3.0	1.5	3.1	3.4	9.0	3.0	1.3	2.3	4.4	1.8	4.4	2.7
Glossitis	0.1	0.4	0.7	1.1	0.7	0.3	0.3	0.0	0.7	1.8	1.1	0.4
Thyroid Enlargement												
Grade I	2.7	1.0	0.0	0.0	0.7	1.8	8.9	6.8	8.9	8.9	5.4	8.4
Grades II and III	0.3	0.0	0.0	0.0	0.0	0.2	1.1	3.0	1.5	7.2	0.0	1.6
Umbilical Hernia												
-slight	9.4	2.6	2.6	0.0	0.0	6.5	7.7	0.0	0.0	11.1	0.0	6.9
-moderate to severe	6.2	2.2	2.6	0.0	0.0	4.5	5.7	0.0	0.0	0.0	0.0	4.5
Lower Extremities												
Bilateral edema	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.8	0.0	1.1	0.2

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TABLE 79. CLINICAL FINDINGS BY LOCATION, ABBREVIATED EXAMINATIONS, NIGERIA

	Males						Females						
	5-14 years												
	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Total Number Examined	173	149	92	221	193	241	72	44	48	202	253	132	1,820
	Percent Prevalence												
Skin													
Nasolabial seborrhea	0.6	4.0	3.3	1.4	0.0	0.0	0.0	4.5	0.0	3.0	0.8	0.8	
Follicular hyperkeratosis	0.0	0.7	1.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	
Yellow palms:													
slight	47.9	41.8	29.2	37.7	31.2	20.7	55.7	42.9	33.3	38.1	25.0	19.7	
moderate to severe	50.0	45.4	5.6	42.8	42.6	11.2	31.2	35.8	4.2	32.2	37.5	19.8	
Lips													
Angular lesions	2.3	8.1	0.0	0.9	6.7	5.4	1.4	6.8	0.0	1.5	2.4	4.5	
Angular scars	9.8	1.3	0.0	5.9	7.3	7.9	12.5	0.0	0.0	5.4	5.5	6.8	
Cheilosis:													
slight	1.2	2.0	0.0	0.0	0.0	3.7	4.2	0.0	0.0	0.5	1.2	0.8	
moderate to severe	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.8	
Gums													
Swollen red papillae													
localized	2.9	4.0	7.6	5.9	7.8	10.0	1.4	6.8	2.1	4.5	7.9	9.1	
diffuse	1.7	6.7	0.0	0.9	5.7	5.8	0.0	0.0	0.0	0.5	2.0	6.8	
Tongue													
Filiform papillary atrophy:													
slight	3.5	4.7	1.1	2.7	4.1	2.5	0.0	2.3	10.4	2.5	3.6	3.0	
moderate to severe	1.7	2.7	1.1	1.8	3.1	5.8	0.0	2.3	2.1	0.5	2.4	6.0	
Glossitis	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.4	0.8	
Thyroid Enlargement													
Grade I	3.5	4.0	0.0	5.0	2.6	0.4	8.3	13.6	10.4	11.9	9.9	0.8	
Grades II and III	0.0	1.3	1.1	0.0	0.0	0.0	0.0	4.5	0.0	0.5	2.1	0.0	
Umbilical Hernia													
slight	13.9	6.1		10.0	10.3	2.6	12.7	0.0		8.0	3.8	12.8	
moderate to severe	7.4	14.3		5.5	1.5	5.1	5.4	9.5		6.5	1.9	8.5	
Lower Extremities													
Bilateral edema	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

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TABLE 79. (continued) CLINICAL FINDINGS BY LOCATION, ABBREVIATED EXAMINATIONS, NIGERIA

Location	Males 15+ years						Females 15+ years						Total 15+ years
	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	
Total Number Examined	301	179	22	32	147	221	102	7	20	19	169	99	1,318
	Percent Prevalence												
Skin													
Nasolabial seborrhea	13.6	16.8	4.5	3.1	12.2	4.1	1.0	14.3	10.0	0.0	4.1	4.0	
Follicular hyperkeratosis	0.0	1.7	13.6	0.0	7.5	0.5	1.0	0.0	0.0	0.0	0.6	0.0	
Yellow palms-slight	34.6	37.4	22.7	46.9	9.5	26.4	25.5	57.1	25.0	57.9	71.0	42.4	
-moderate to severe	46.2	48.0	4.5	25.0	8.2	23.9	51.0	42.9	0.0	10.5	2.4	34.3	
Lips													
Angular lesions	0.3	0.0	0.0	0.0	3.4	4.5	0.0	0.0	5.0	0.0	2.4	8.1	
Angular scars	4.0	5.0	18.2	3.1	5.4	7.2	2.9	0.0	25.0	5.3	7.1	14.1	
Cheilosis-slight	2.0	0.0	0.0	3.1	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	
-moderate to severe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.0	
Gums													
Swollen red papillae													
-localized	7.6	1.7	4.5	3.1	15.6	6.3	12.7	0.0	5.0	0.0	13.1	6.1	
-diffuse	4.3	2.8	0.0	3.1	7.5	8.1	2.0	0.0	0.0	0.0	7.1	7.1	
Tongue													
Filiform papillary atrophy													
-slight	0.3	2.2	4.5	9.4	4.8	5.0	2.9	0.0	5.0	0.0	6.5	12.1	
-moderate to severe	1.3	0.6	0.0	0.0	6.1	5.9	1.0	0.0	0.0	0.0	2.4	9.1	
Glossitis	0.3	0.0	0.0	0.0	0.7	1.4	0.0	0.0	0.0	0.0	1.2	1.0	
Thyroid Enlargement													
-Grade I	1.3	0.0	0.0	0.0	0.7	0.5	10.8	14.3	15.0	15.8	5.9	3.0	
-Grades II and III	0.0	0.0	0.0	0.0	0.0	0.0	5.9	0.0	5.0	0.0	0.6	2.0	
Umbilical Hernia													
-slight	2.7	0.0	0.0	0.0	0.0	2.2	2.0	0.0	0.0	0.0	0.0	0.0	
-moderate to severe	2.7	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Lower Extremities													
Bilateral edema	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	

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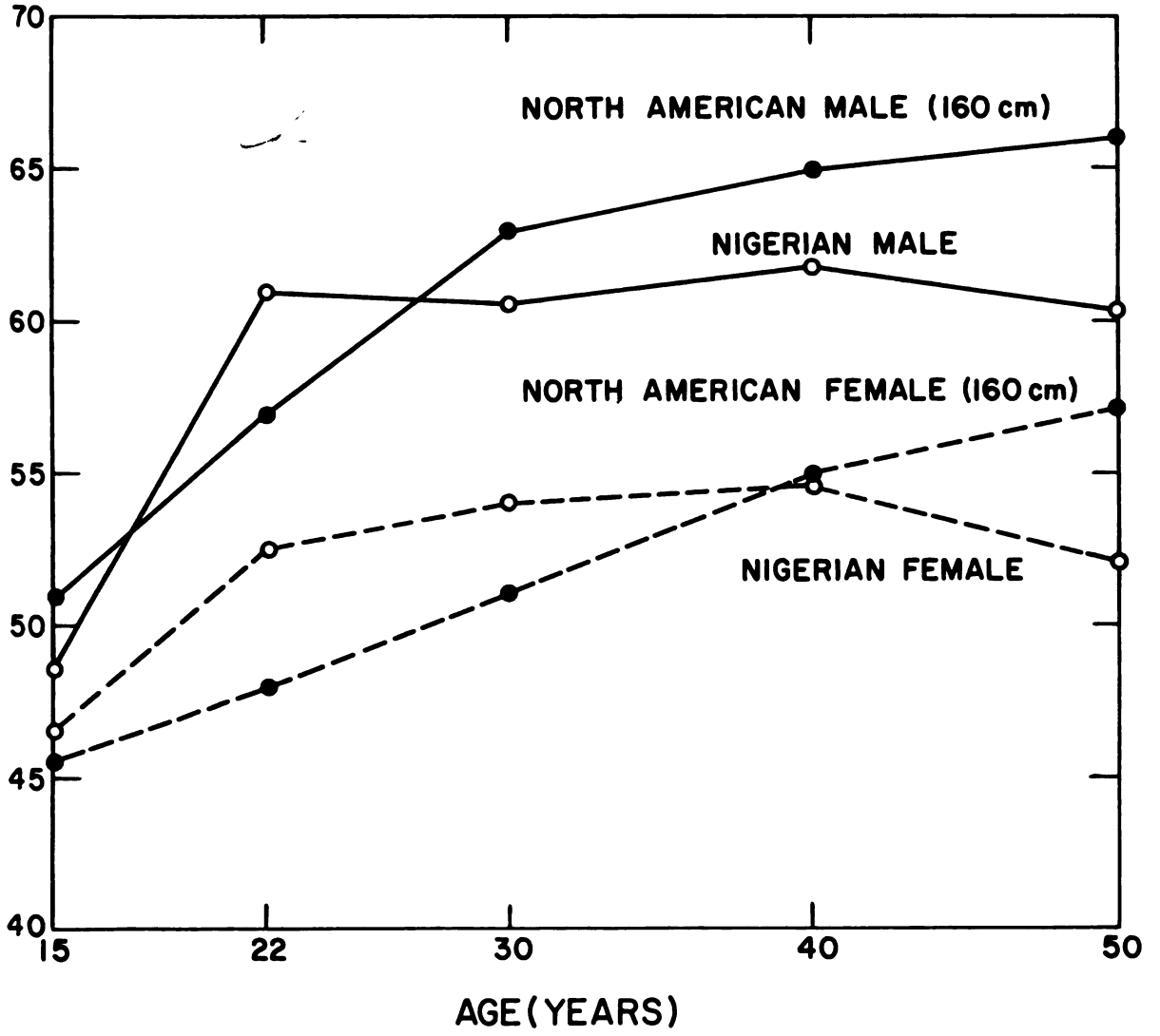
Figure 8. COMPARISON OF AVERAGE WEIGHT BY AGE OF ADULTS OF SAME HEIGHT IN NIGERIA AND NORTH AMERICA



North American data from Society of Actuaries Build and Blood Pressure Study.

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Figure 9. SKINFOLD MEASUREMENTS BY AGE AND SEX, NIGERIA

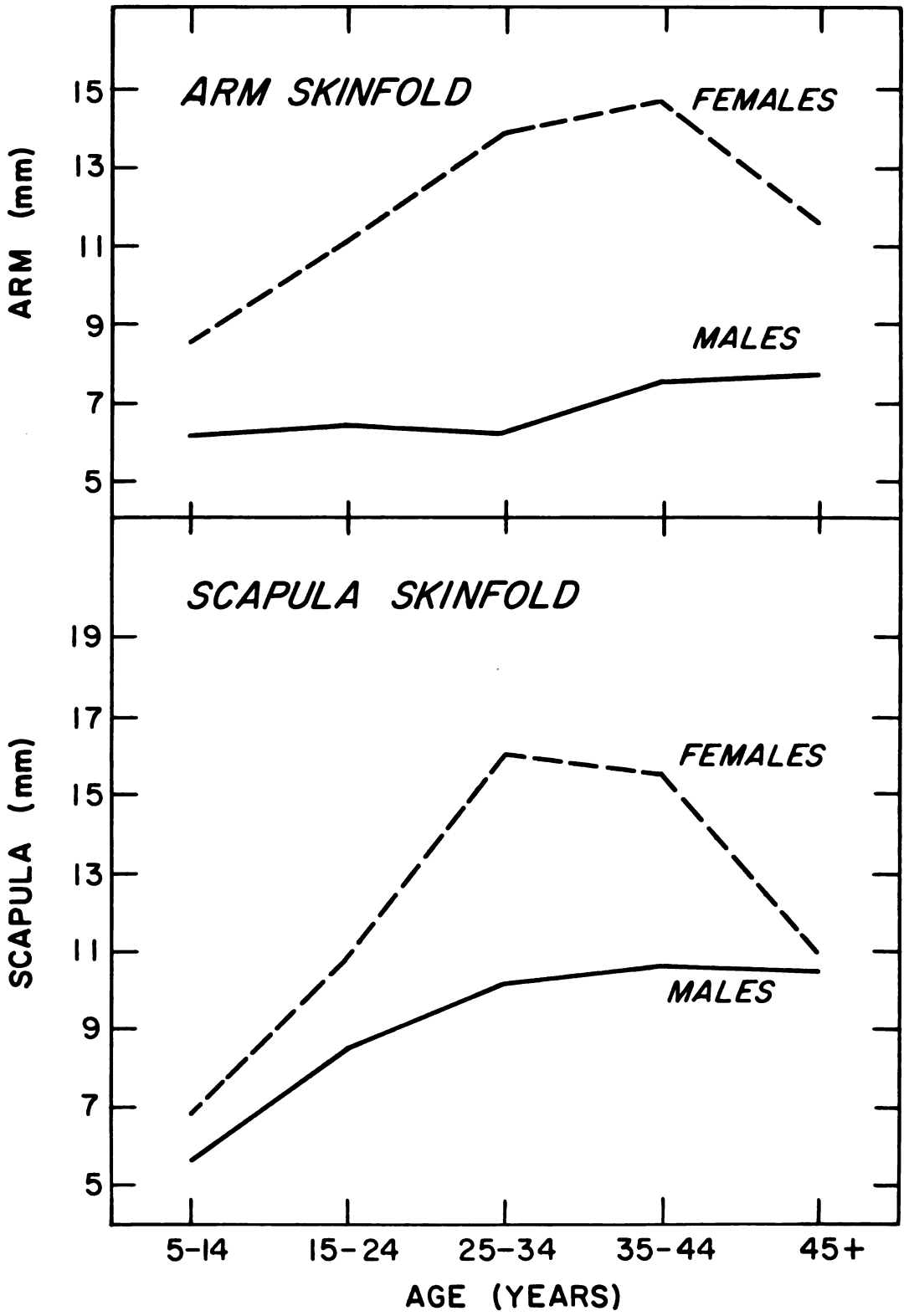

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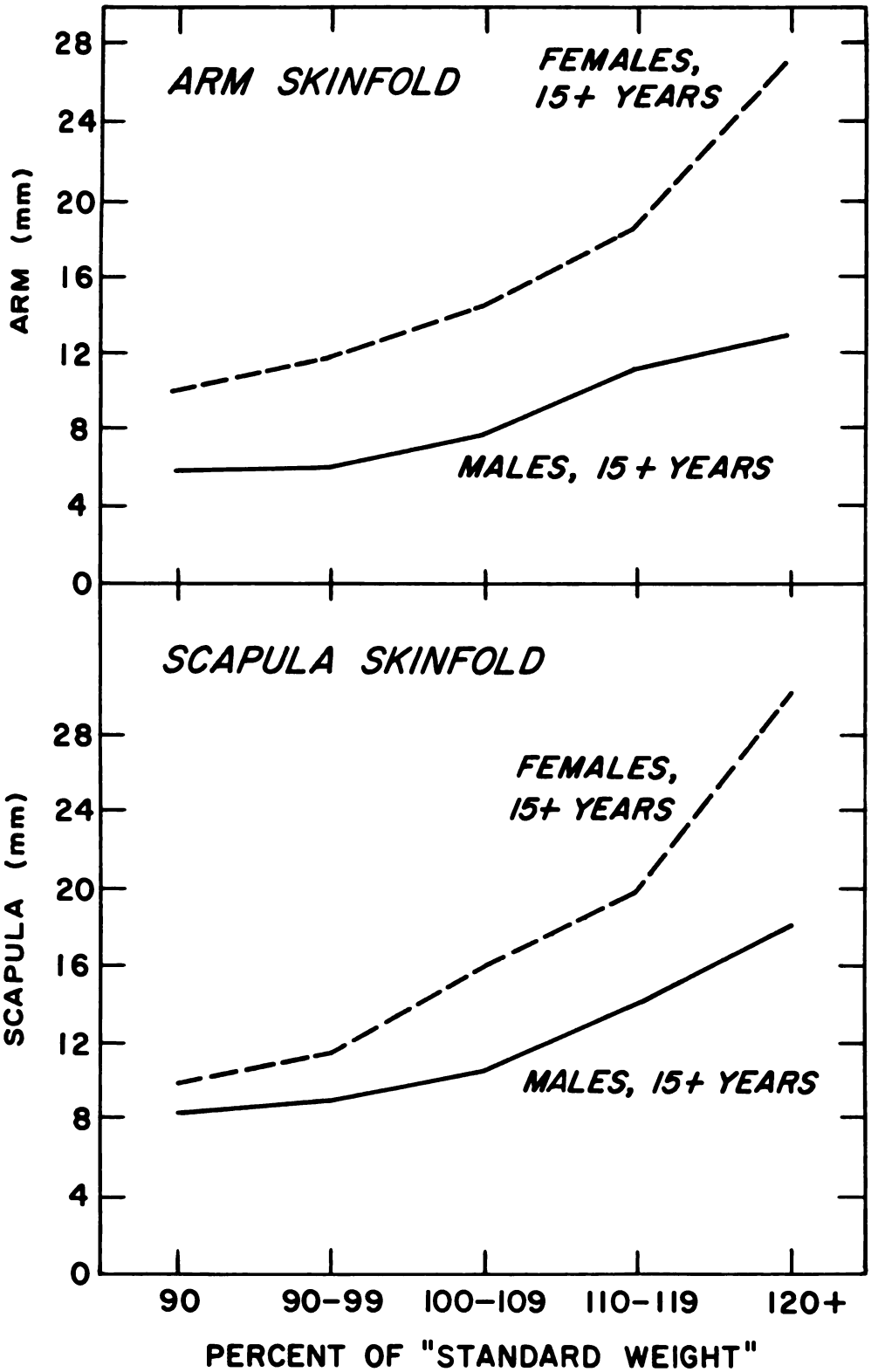
Figure 10. SKINFOLD MEASUREMENTS BY SEX AND PERCENT "STANDARD WEIGHT", ADULTS, 15+ YEARS, NIGERIA



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or interference with body growth and development was an impression of examiners in many sites, physical manifestations of nutritional deficiency disease were not widely prevalent. Those lesions which were of significance and most commonly observed were nasolabial seborrhea, angular lesions, angular scars, swollen red papillae of the gums, filiform papillary atrophy, and thyroid enlargement.

Nasolabial seborrhea was observed in the general population, with greatest frequency among males between ages 15 and 34. Among children and adults of both sexes, this finding was most evident in the Savannah region; but among adult males the prevalence of nasolabial seborrhea exceeds 12 percent in the Derived Savannah and Rain Forest regions as well as the Savannah region. Angular lesions were observed approximately as frequently in the total population examined among both sexes and at every age. In the Coastal region the prevalence of this lesion exceeded 4 percent of children and adults of both sexes examined, while in the Savannah and rain Forest regions it exceeded 4 percent only among children. In the Rain Forest and Coastal regions, more than 5 percent of children and adults of both sexes were observed to have angular scars, thus reflecting the prevalence of angular lesions in these areas. However, in the Derived Savannah region, angular scars were primarily detected among children and were found among more than 9 percent of boys and girls.

Both localized and diffusely swollen red gum papillae were more common in the total population examined among men and women older than 25 years and were particularly prevalent in the Rain Forest and Coastal regions. Diffuse swelling and erythema of papillae in adult men and women were more common when the body weight for a given height was less than 90 percent of the "standard weight." Moderate and severe filiform papillary atrophy involved 9 percent of the total population of males examined over age 45, but among boys and girls as well as adults of both sexes, the prevalence of moderate to severe forms of this lesion exceeded 5 percent and 2 percent in the Coastal and Rain Forest regions, respectively. This lesion did not appear to be correlated with the percent of "standard weight" of individuals. The prevalence of thyroid enlargement of Grades I, II, and III (WHO classification; 3) was much greater in females than in males of all ages and was highest in females during the late childbearing ages but lowest in females after menopause (Figure 11). In Table 80 the results of thyroid surveys in the areas in and around Pankshin, Jos, and Asaba are recorded. The prevalence of Grade II and III enlargement of the thyroid gland was greater in the Plateau region than in the Rain Forest.

Early in the survey, yellow palms were noted to be quite common (see above under Pediatric Study). This sign of carotenemia in either mild, moderate, or marked forms was observed in over 64 percent of males and

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TABLE 80. PERCENT PREVALENCE OF THYROID ENLARGEMENT BY SEX AND AGE IN PLATEAU AND RAIN FOREST REGIONS

Plateau Region (Pankshin and Jos)

Sex	Age (years)	Number Examined	Degree of Thyroid Enlargement		
			Grade I	Grade II	Grade III
			Percent Prevalence		
Male	5-11	354	13.8	0.6	0.0
	11-20	204	13.7	1.5	0.0
	20+	132	8.3	0.0	0.8
Female	5-11	243	16.0	1.2	0.0
	11-20	109	24.7	7.3	1.8
	20+	384	26.1	10.2	4.7

Rain Forest Region (Asaba)

Sex	Age (years)	Number Examined	Degree of Thyroid Enlargement		
			Grade I	Grade II	Grade III
			Percent Prevalence		
Male	5-11	109	0.9	0.0	0.0
	11-20	200	0.0	0.0	0.0
	20+	0	-	-	-
Female	5-11	24	41.7	0.0	0.0
	11-20	108	16.7	0.0	0.0
	20+	0	-	-	--

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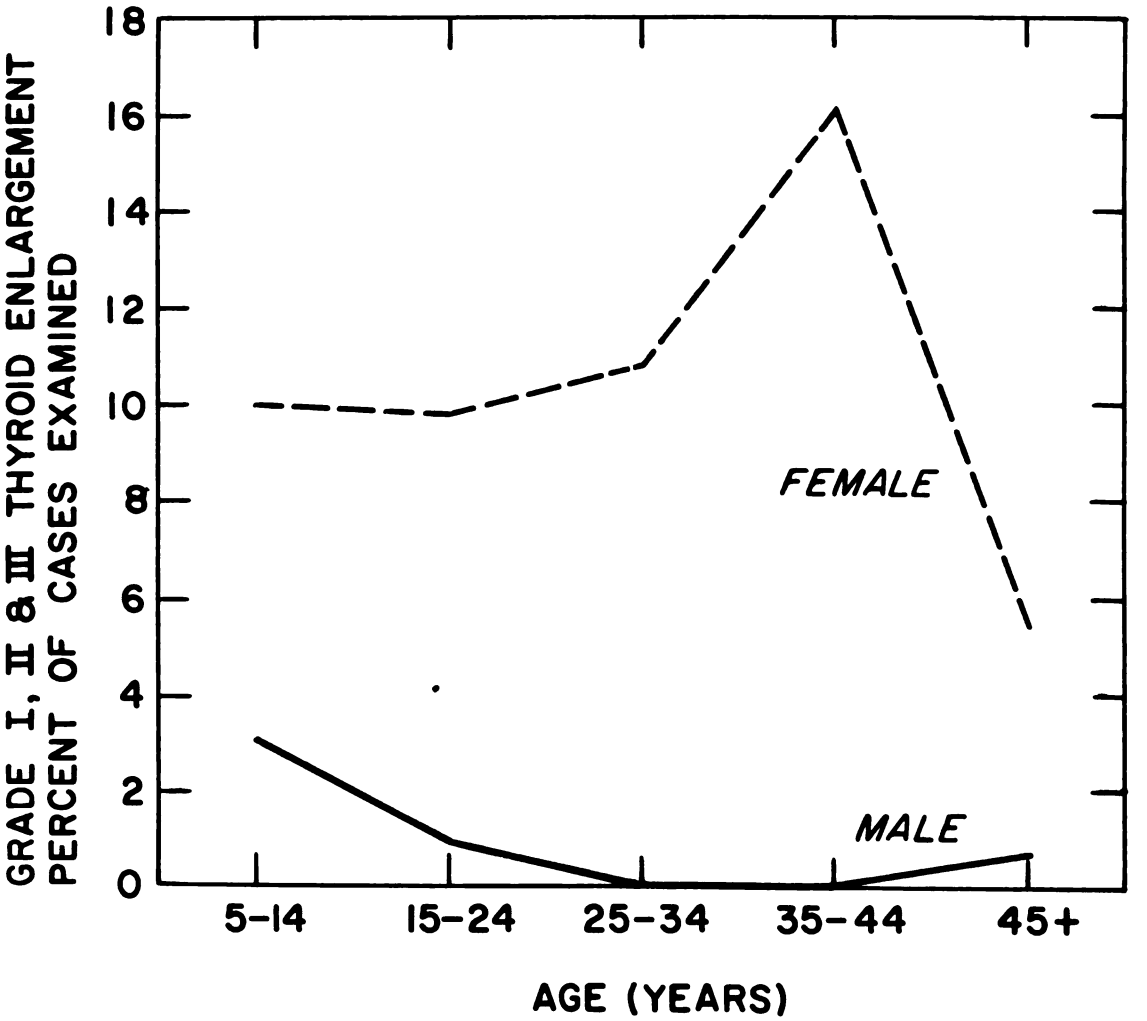
Figure 11. THYROID ENLARGEMENT BY AGE AND SEX, NIGERIA



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females in all age groups. This sign was least prominent in the Plateau region where one-third to one-fourth of the children and adults, respectively, had yellow palms. Yellow palms reflect carotenemia resulting from the common utilization of palm oil in preparing diets.

Another finding which impressed clinicians was the high prevalence of umbilical herniae among children. As noted in Table 78, 5.7 percent or more of males and females between ages 5 and 14 had prominent umbilical herniae in all regions where this finding was looked for. The prevalence was equal in males and females and unrelated to the percent of "standard weight." In contrast, the prevalence of umbilical herniae among adults was low.

Detailed physical examinations were done on 1,070 persons, or about 25 percent of the total group of 4,201 examined (Police not included). From the measurements and observations included in the detailed examination, certain additional information is available.

There was an increase in mean systolic and diastolic blood pressure with age in both sexes (Figure 12) but little variation in these pressures with percent of "standard weight" in both sexes (Figure 13). Among individuals above 15 years of age, 4 percent of males and 10 percent of females had systolic pressures above 150 mm Hg, while 3 percent of males and 8 percent of females had diastolic pressures above 100 mm Hg. Hypertension was not more prevalent in any one region surveyed.

Characteristics of the population sample which had detailed examinations are recorded by age and sex in Table 81 and by location in Table 82. These tables include the prevalence of selected physical manifestations of possible nutritional origin which were not part of the abbreviated clinical examination.

The prevalence of hepatic enlargement which was more than 2 cm below the costal margin was 7.1 and 6.6 percent, respectively, for all males and females examined. Hepatomegaly occurred primarily in the 5 to 14 year age group and was most prominent in the urban Federal District and the Rain Forest regions. Splenomegaly was observed in 21.9 and 19.8 percent, respectively, of all males and females examined and was a common finding in all regions. Neither hepatomegaly nor splenomegaly varied notably with variations in the percent of "standard weight."

Xerosis conjunctivae was observed in over 18 percent of the males and females over the age of 45. This change in the eyes was observed primarily in the Plateau region and among individuals under 100 percent of "standard weight." Thickening of the bulbar conjunctivae was very common in all ages and in all regions, but the prevalence of this finding exceeded 50 percent in the population of males and females older than 25 years.

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Figure 12. MEAN SYSTOLIC AND DIASTOLIC BLOOD PRESSURE LEVELS BY SEX AND AGE, NIGERIA

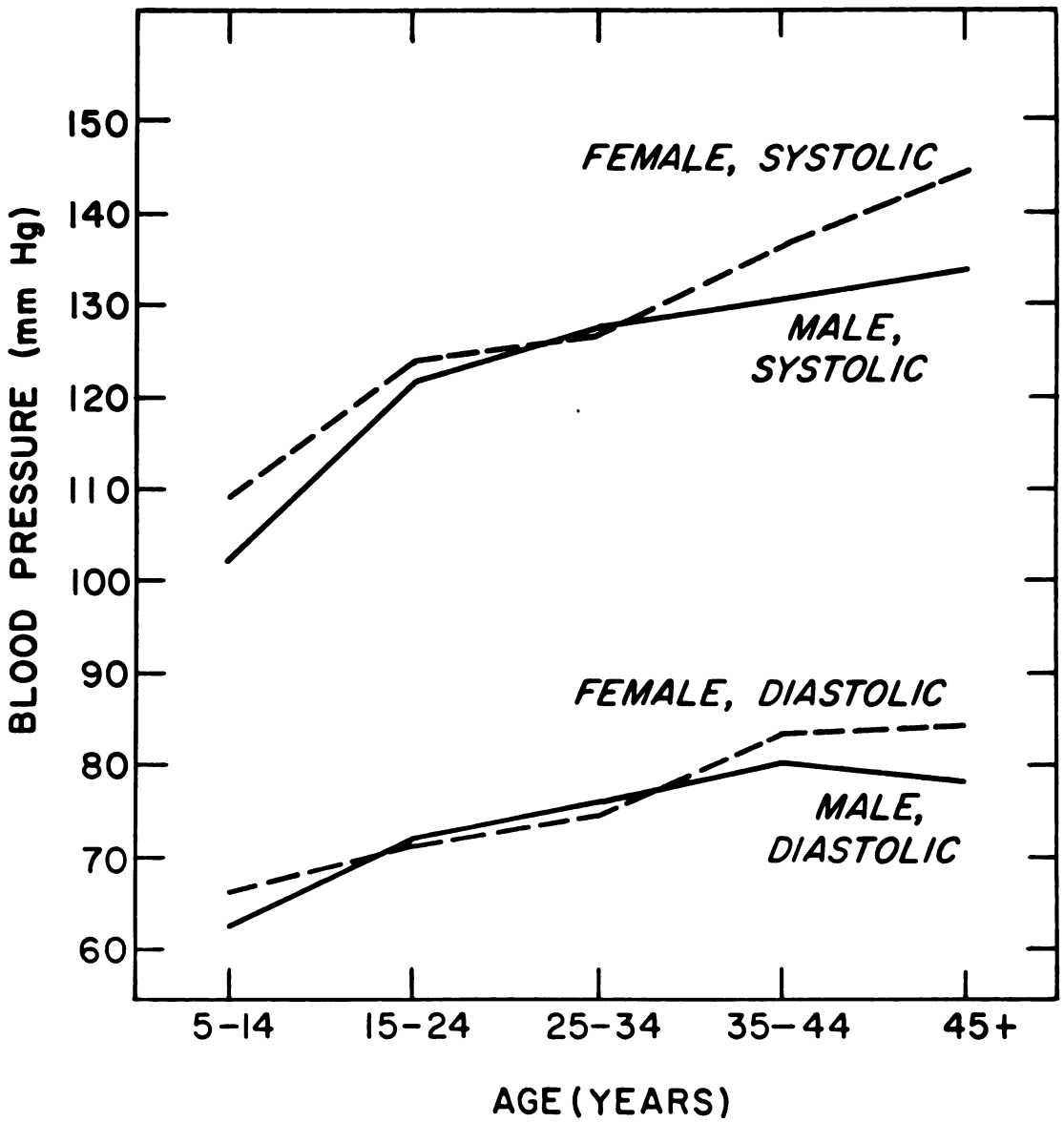

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Figure 13. MEAN SYSTOLIC AND DIASTOLIC BLOOD PRESSURE BY SEX AND PERCENT OF "STANDARD WEIGHT", ADULTS, 15+ YEARS, NIGERIA

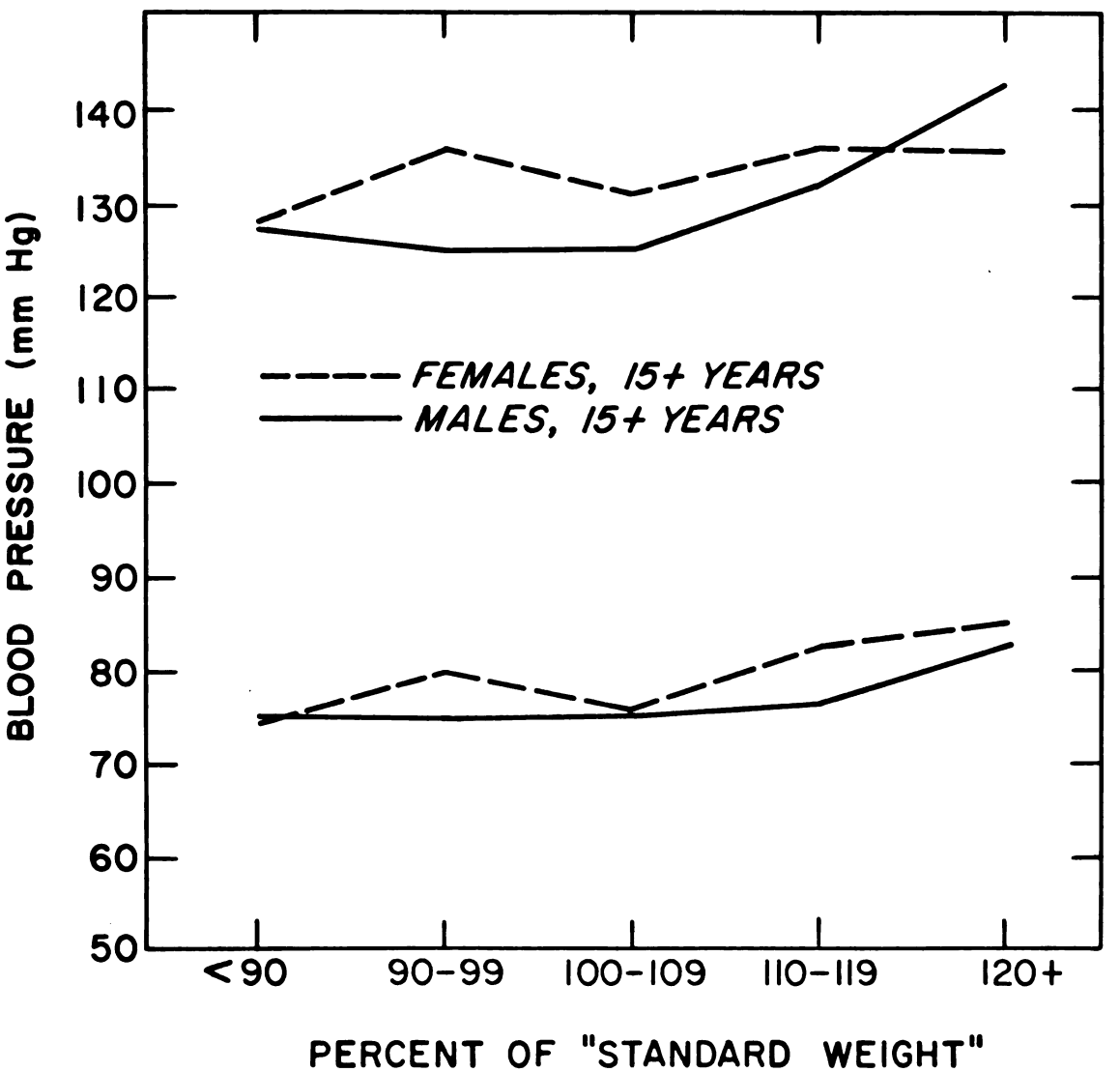

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TABLE 81. SELECTED CLINICAL FINDINGS BY SEX AND AGE, DETAILED EXAMINATIONS, NIGERIA

Sex	Males						Females					
Age (years)	5-14	15-24	25-34	35-44	45+	Total	5-14	15-24	25-34	35-44	45+	Total
Total Number	186	110	42	36	37	411	153	29	22	14	24	242
	Percent Prevalence											
Blood Pressure												
Systolic, over 150mm Hg	0.6	2.7	9.5	14.3	16.2		0.0	3.4	13.6	35.7	29.2	
Diastolic, over 100mm Hg	0.0	0.0	0.0	11.4	5.4		0.7	3.4	0.0	14.3	16.7	
Eyes												
Xerosis conjunctivae	8.6	0.0	0.0	0.0	18.9	5.6	2.0	0.0	0.0	7.1	20.8	3.7
Thickened bulbar conjunctivae	20.4	31.8	57.1	66.7	64.9	35.3	16.3	17.2	50.0	64.3	70.8	27.7
Teeth												
Worn teeth	7.5	4.5	47.6	66.7	54.1	20.2	4.6	20.7	36.4	57.1	66.7	18.6
Missing teeth-1 to 4	11.8	4.5	9.5	5.6	29.7	10.7	4.6	3.4	18.2	35.7	12.5	8.3
-5 to 31	0.0	0.9	2.4	8.3	13.5	2.5	0.0	0.0	0.0	0.0	41.7	4.1
Gums												
Marginal redness	12.9	12.7	9.5	30.6	10.8	13.9	11.1	6.9	9.1	14.3	12.5	10.7
Marginal swelling	10.7	3.6	14.3	16.7	10.8	9.7	17.0	17.2	4.5	7.1	29.2	16.5
Atrophy of papillae	3.2	0.0	7.1	25.0	29.7	7.1	1.3	3.4	0.0	21.4	45.8	7.0
Recession	9.7	5.5	28.6	50.0	78.4	20.2	10.5	6.9	9.1	64.3	70.8	19.0
Bleeding	3.2	0.0	0.0	0.0	0.0	1.5	1.3	0.0	0.0	0.0	0.0	0.8
Debris or calculus	21.5	10.0	23.8	30.6	32.4	20.4	11.8	10.3	4.5	35.7	25.0	
Tongue												
Geographic	1.1	0.9	4.8	0.0	0.0	1.2	0.7	0.0	4.5	0.0	0.0	0.8
Furrowed	1.1	3.6	7.1	11.1	16.2	4.6	2.6	6.9	9.1	14.3	37.5	7.9
Fissured	0.0	0.9	0.0	0.0	0.0	0.2	0.7	0.0	0.0	0.0	4.2	0.8
Lateral or tip redness	0.0	0.0	2.4	5.6	2.7	1.0	2.6	6.9	0.0	0.0	0.0	2.5
Abdomen												
Hepatomegaly-under 2cm	4.3	0.0	0.0	0.0	2.7	2.1	8.5	0.0	0.0	0.0	0.0	5.4
-over 2cm	12.4	2.7	0.0	2.8	5.4	7.1	9.9	0.0	4.5	0.0	0.0	6.6
Splenomegaly	30.1	11.8	19.0	19.4	16.2	21.9	19.0	17.2	13.6	42.4	20.8	19.8
Neurological												
Loss of knee jerk	0.5	0.0	2.4	0.0	2.7	0.7	0.0	0.0	0.0	7.1	4.2	0.8
Loss of vibratory sense	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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TABLE 82. SELECTED CLINICAL FINDINGS BY LOCATION, DETAILED EXAMINATIONS, NIGERIA

Location	Males 5-14 years						Females 5-14 years						Total
	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	
Total Number Examined	43	37	12	35	28	31	11	15	4	46	64	13	339
	Percent Prevalence												
Eyes													
Xerosis conjunctivae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Thickened bulbar conjunctivae	37.2	32.4	24.0	0.0	10.7	12.9	18.2	33.3	0.0	2.2	26.6	0.0	
Teeth													
Worn teeth	11.6	2.7	8.3	2.9	14.3	6.5	0.0	0.0	0.0	0.0	10.9	0.0	
Missing teeth-1 to 4	20.9	2.7	0.0	2.9	14.3	22.6	0.0	6.7	0.0	8.7	1.6	7.7	
-5 to 31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Gums													
Marginal redness	16.3	2.7	8.3	11.4	17.9	19.4	0.0	0.0	0.0	6.5	17.2	23.1	
Marginal swelling	14.0	8.1	0.0	0.0	35.7	3.2	0.0	20.0	0.0	0.0	32.8	15.4	
Atrophy of papillae	4.7	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	3.1	0.0	
Recession	14.0	0.0	0.0	0.0	21.4	19.4	18.2	0.0	0.0	2.2	18.8	7.7	
Debris or calculus	55.8	2.7	0.0	14.3	25.0	9.7	54.5	20.0	0.0	2.2	12.5	0.0	
Tongue													
Furrowed	0.0	0.0	0.0	0.0	0.0	6.5	9.1	6.7	0.0	0.0	3.1	0.0	
Lateral or tip redness	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	0.0	
Abdomen													
Hepatomegaly-under 2cm	0.0	2.7	0.0	8.6	14.3	0.0	9.1	6.7	0.0	13.0	4.7	7.7	
-over 2cm	7.0	0.0	8.3	34.3	21.5	3.2	0.0	0.0	0.0	19.6	9.4	0.0	
Splenomegaly	46.5	18.9	33.3	20.0	28.6	32.3	18.2	13.3	0.0	15.2	24.3	23.1	
Neurological													
Loss of knee jerk	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	

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TABLE 82. (continued) SELECTED CLINICAL FINDINGS BY LOCATION, DETAILED EXAMINATIONS, NIGERIA

Location	Males 15+ years							Females 15+ years					
	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal		Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total 15+ years
Total Number Examined	63	38	6	14	57	47	23	1	4	6	37	18	314
	Percent Prevalence												
Eyes													
Xerosis conjunctivae	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0	
Thickened bulbar conjunctivae	3.3	57.9	66.7	50.0	57.9	42.6	43.5	0.0	75.0	66.7	37.8	61.1	
Teeth													
Worn teeth	27.0	5.3	50.0	21.4	56.1	25.5	56.5	0.0	50.0	16.7	29.7	61.1	
Missing teeth-1 to 4	6.3	5.3	33.3	21.4	15.8	4.3	13.0	0.0	25.0	0.0	10.8	16.7	
-5 to 31	6.4	0.0	0.0	0.0	8.8	2.1	4.3	0.0	25.0	16.7	10.8	22.3	
Gums													
Marginal redness	20.6	13.2	16.7	14.3	14.0	8.5	8.7	0.0	0.0	0.0	5.4	27.8	
Marginal swelling	3.2	2.6	0.0	0.0	19.3	12.8	0.0	0.0	0.0	0.0	29.7	16.7	
Atrophy of papillae	9.5	0.0	0.0	0.0	21.1	10.6	30.4	0.0	0.0	0.0	13.5	16.7	
Recession	23.8	2.6	50.0	35.7	54.5	21.3	39.1	0.0	25.0	16.7	40.6	22.2	
Debris or calculus	19.0	2.6	0.0	28.6	31.6	19.1	8.7	0.0	0.0	0.0	24.3	22.2	
Tongue													
Furrowed	7.9	7.9	16.7	0.0	7.0	8.5	13.0	0.0	0.0	0.0	18.9	27.8	
Lateral or tip redness	0.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0	5.4	0.0	
Abdomen													
Hepatomegaly-under 2cm	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
-over 2cm	3.2	0.0	0.0	7.1	3.6	2.1	0.0	0.0	0.0	0.0	0.0	5.6	
Splenomegaly	22.2	5.3	16.7	14.3	7.0	23.4	43.5	0.0	0.0	0.0	10.8	27.8	
Neurological													
Loss of knee jerk	0.0	0.0	0.0	0.0	1.8	2.1	0.0	0.0	0.0	0.0	2.7	5.6	

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The tongue was furrowed in more than 11 percent of all males and females older than age 35. Bleeding gums were uncommon, but marginal redness of the gums and/or marginal swelling of the gums occurred in over 9 percent of all males and females. These lesions were common in all age groups and were observed primarily in the Rain Forest and Coastal regions. Atrophy of gum papillae and recession of the gums were recorded in 7 percent and 20 percent, respectively, of all males and females examined. These gum alterations were observed primarily in both sexes above age 35 and appeared most often in adults in the Derived Savannah, Rain Forest, and Coastal regions.

More than four missing teeth was a common finding in males and females over age 45, and worn teeth were observed primarily in males and females above age 25. The latter finding was reported in over 18 percent of the total population of males and females examined and was a notable finding among adults in all regions. The high incidence of debris and calculus in men, women, boys, and girls is covered in detail in the following dental chapter (X).

Clinical Impressions

Water was usually obtained from a communal source. Water purification and sewage disposal systems were lacking or inadequate in most of the communities visited. Undoubtedly, a prime need is to develop sanitary controls and improved sanitation within homes and communities. This effort might well produce immediate gains in health.

It was observed generally that young children and adolescents were active physically. Obesity was a rare occurrence in children and was infrequently seen in adults. Although gross manifestations of nutritional deficiency disease were seen in only a few individuals, the occurrence of isolated physical signs, possibly resulting from malnutrition or deficiency disorders, was relatively common.

In all of the hospitals visited, marasmus and kwashiorkor were seen in young children. Malaria, leprosy, schistosomiasis, and amebic hepatitis are common entities, as are a variety of enteric parasitic diseases. Tetanus and the sequelae of poliomyelitis were observed. The syndrome of idiopathic myocardial hypertrophy was not a common finding. Noma (see Chapter X), Burkitt's lymphoma, and African trypanosomiasis were not observed among the sample, although they were seen in hospitalized groups.

Liver disease, especially cirrhosis, is an important medical problem in Nigeria, although it was not specifically studied during this survey. The incidence of primary carcinoma of the liver among patients with

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cirrhosis is stated to be high in Nigeria. The causes of the cirrhosis and the complicating primary carcinoma of the liver are not known. Although a factor in some countries, alcoholism does not appear to be a predominant problem in Nigeria. Viral hepatitis may perhaps lead to cirrhosis. Deficiency diseases may be a contributing factor in some instances, but evidence does not indicate that this is the major factor. The possibility that some fungal toxin (mycotoxin) such as aflatoxin may produce cirrhosis and even induce primary carcinoma deserves further study.

Pregnant or Lactating Women

Detailed examinations of 257 pregnant or lactating women were conducted in antenatal clinics in all six regions of Nigeria. Only 4.7 percent of the women were older than 34 years, while 49 percent were between 25 and 34 years. Although none had hypertension, 12.8 percent were heavier than 120 percent of the "standard weight," for adult women. This increased weight appears to be due to an increase in subcutaneous fat rather than due to edema or the intrauterine contents, because, among those heavier than 120 percent of the "standard weight," 47 percent had arm and scapula skinfold thicknesses greater than 20 mm. This increase in skinfold thickness was observed in all regions, primarily among women older than 24 years. Tachycardia was detected in over 10 percent of pregnant or lactating women examined in the Rain Forest and Coastal regions and was not related to either age or the percent of "standard weight." It may be a reflection of anemia.

Other clinical findings on the detailed examination are presented in Table 83. Thickening of bulbar conjunctivae was a common finding in all regions. Nasolabial seborrhea was detected primarily in the Plateau, Urban Federal District, and Coastal regions. In the Derived Savannah, Rain Forest, and Coastal regions the prevalence of angular scars exceeded 5 percent, while the prevalance of cheilosis, marginal redness of gums and debris or calculus formation on teeth each exceeded 10 percent. Filiform papillary atrophy of the tongue and furrowed tongue were recorded in over 10 and 5 percent, respectively, of women in each region. Only in the Rain Forest was redness of the tip or lateral aspects of the tongue a common finding. Except in the Plateau region, more than 30 percent of women had yellow palms.

Thyroid enlargement was three times more common in the Plateau region than in any other region. Hepatomegaly was a rare finding, but splenomegaly was common, especially in the Plateau and Coastal regions where it was observed in 18.2 and 29.4 percent of women, respectively. Except for splenomegaly and recession of gums, both of which were more common in women older than 24 years, the prevalence of each physical finding in pregnant or lactating women between 15 and 24 years of age was approximately the same as in those between 25 and 34 years of age.

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TABLE CLINICAL FINDINGS AMONG PREGNANT OR LACTATING WOMEN, DETAILED EXAMINATION, NIGERIA

Number of Examinations		257 Percent Prevalence
Eyes	Thickened bulbar conjunctivae	41.6
	Xerosis of conjunctivae	0.4
Skin	Nasolabial seborrhea	5.4
	Yellow palms	70.8
	Follicular hyperkeratosis	1.6
	Xerosis	1.6
	Crackled skin	0.8
Lips	Angular lesions	1.2
	Angular scars	6.6
	Cheilosis	16.7
Gums	Marginal redness	16.0
	Marginal swelling	2.7
	Recession	24.9
	Swollen red papillae, localized	8.2
	diffuse	1.9
Teeth	Worn teeth	35.0
	1 to 4 missing	2.3
	Over 4 missing	1.2
	Debris or calculus	16.7
Tongue	Filiform papillary atrophy, slight	7.8
	moderate and severe	7.4
	Geographic	0.4
	Furrowed	4.3
	Fissures	1.6
	Red tip or lateral edge	3.1
	Glossitis	0.4
Thyroid Enlarged	Grade I	8.6
	Grade II and III	0.8
Abdomen	Hepatomegaly	0.4
	Splenomegaly	11.3
Legs	Bilateral edema	1.2
	Loss of knee jerk	2.3
	Loss of vibratory sense	0.8
	Bowed legs	0.4

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Military Personnel

A survey of 676 military personnel was made in the four regions of Nigeria listed in Table 84. From this table it is clear that in all four regions the mean height and weight of military personnel examined equals the median percentile for height and weight of the average North American male adult. This suggests that in comparison to the average Nigerian male, military personnel in Nigeria are a select group. The percent prevalence of clinical findings in the abbreviated and detailed physical examination is presented by region in Tables 85 and 86 respectively. It was the general impression of team physicians that the personnel examined were in excellent general physical condition.

The physical abnormalities most commonly observed during the abbreviated examination were nasolabial seborrhea, yellow palms, red swollen gingival papillae, and filiform papillary atrophy of the tongue. Nasolabial seborrhea was most evident in the 25 to 34 year age group and was particularly prominent in both the Derived Savannah region and the Urban Federal District where the prevalence of this finding exceeded that in the average Nigerian adult male. Swollen red gingival papillae were common findings in all areas at all ages with the exception of the Savannah region. Filiform papillary atrophy was approximately as common in all regions but less prevalent among military personnel than in the average Nigerian male older than 24 years. Grade I enlargement of the thyroid exceeded 3 percent of the populations examined only in the Derived Savannah region.

Additional physical findings most commonly observed in the detailed physical examination were thickening of bulbar conjunctivae, worn teeth, marginal redness and swelling of gums, recession of gums, debris and/or calculus formation on teeth, furrowed tongues, hepatomegaly, splenomegaly, and mild hypertension. None of these manifestations were related to the percent of "standard weight." Except for splenomegaly which was less prevalent than in the average Nigerian male, these physical findings were observed approximately as frequently as in the general young adult male population.

Thickening of bulbar conjunctivae was a common finding in all regions at all ages. Worn teeth were most often observed in those over age 35, particularly in the Urban Federal District and Rain Forest regions. More than four missing teeth was not encountered, but 1 to 4 missing teeth were most frequently recorded in the Savannah and Rain Forest regions. Marginal redness with swelling of gums and atrophy of gingival papillae occurred with greatest frequency in the Derived Savannah region, an area where debris and/or calculus formation on the teeth was most often observed. On the other hand, recession of gums was observed primarily in the Rain Forest and among personnel 24 to 34 years in age. A furrowed tongue and lateral or tip redness both predominated in the Derived Savannah region and were not observed in the Rain Forest.

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TABLE 84. MEAN HEIGHT, WEIGHT AND PERCENT OF "STANDARD WEIGHT" BY LOCATION OF MILITARY PERSONNEL AND POLICE CADETS

Region	Number Examined	Height inches	Weight kg	Percent "Standard Weight"
		Military Personnel		
Derived Savannah	59	68.3	69.6	100.7
Savannah	350	67.5	68.1	100.5
Urban Federal District	156	67.4	70.4	104.0
Rain Forest	111	68.2	69.3	100.1
		Police Cadets		
Urban Federal District	130	67.2	66.4	98.6

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TABLE 85. CLINICAL FINDINGS BY LOCATION AMONG MILITARY PERSONNEL AND POLICE CADETS, ABBREVIATED EXAMINATION, NIGERIA

Location	Military Personnel					Police Cadets
	Derived Savannah	Savannah	Urban Federal District	Rain Forest	Total	Urban Federal District
Number of Examinations	59	350	156	111	676	130
	Percent Prevalence					
Skin						
Nasolabial seborrhea	13.6	4.0	19.9	5.4	8.7	14.6
Follicular hyperkeratosis	0.0	0.0	0.0	7.2	1.2	0.0
Yellow palms - slight	20.3	41.5	41.0	-	39.1	45.7
- moderate to severe	74.6	39.4	49.4	-	46.0	24.8
Lips						
Angular lesions	0.0	1.1	0.6	0.9	0.9	0.0
Angular scars	0.0	0.9	0.0	2.7	0.9	6.2
Cheilosis	0.0	0.0	0.0	0.0	0.0	0.0
Gums						
Swollen red papillae						
-localized	15.3	2.3	7.1	6.3	5.2	0.8
-diffuse	8.5	0.6	5.1	14.4	4.6	0.0
Tongue						
Filiform papillary atrophy - slight	1.7	1.4	3.2	0.9	1.8	0.8
-moderate to severe	5.1	2.0	1.9	1.8	2.2	0.8
Glossitis	0.0	1.4	0.0	0.0	0.6	0.0
Thyroid Enlargement						
Grade I	3.2	0.3	0.0	0.0	0.4	2.3
-Grades II and III	0.0	0.0	0.0	0.0	0.0	0.0
Umbilical Hernia						
-slight	3.8	-	-	-	3.8	7.9
-moderate to severe	1.9	-	-	-	1.9	2.4
Lower Extremities						
Bilateral edema	0.0	0.0	0.0	0.0	0.0	0.0

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TABLE 86. SELECTED CLINICAL FINDINGS BY LOCATION AMONG MILITARY PERSONNEL AND POLICE CADETS, DETAILED EXAMINATIONS, NIGERIA

Location	Military Personnel					Police Cadets
	Derived Savannah	Savannah	Urban Federal District	Rain Forest	Total	Urban Federal District
Number of Examinations	17	71	39	33	160	130
	Percent Prevalence					
Eyes						
Xerosis conjunctivae	0.0	0.0	0.0	0.0	0.0	0.0
Thickened bulbar conjunctivae	23.5	43.7	38.5	42.4	40.0	88.5
Teeth						
Worn teeth	5.9	4.2	25.6	15.2	11.9	23.1
Missing teeth (1 to 4)	5.9	12.7	5.1	9.1	9.4	0.0
(5 to 31)	0.0	0.0	0.0	0.0	0.0	0.0
Gums						
Marginal redness	17.6	12.7	5.1	12.1	11.2	0.0
Marginal swelling	82.4	1.4	2.6	3.0	10.6	0.0
Atrophy of papillae	5.9	0.0	0.0	0.0	0.6	0.0
Recession	0.0	14.1	7.7	36.4	15.6	50.0
Debris and/or calculus	29.4	14.1	0.0	0.0	9.4	0.0
Tongue						
Furrowed	17.6	4.2	5.1	0.0	5.0	0.0
Lateral or tip redness	5.9	0.0	0.0	0.0	0.6	0.0
Abdomen						
Hepatomegaly (under 2 cm)	0.0	0.0	0.0	3.0	0.6	0.0
(over 2 cm)	0.0	5.6	5.1	0.0	3.8	3.8
Splenomegaly	0.0	16.9	7.7	6.1	10.6	3.8
Neurological						
Loss of knee jerk	0.0	1.4	0.0	0.0	0.6	0.0

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Hepatomegaly and splenomegaly were most prevalent in the Savannah and Urban Federal District among both the young and older personnel.

Blood pressures exceeding 150 mm Hg systolic and 100 mm Hg diastolic were observed in over 5 percent of the total army population. Mild hypertension tended to appear most frequently after age 25; it was no more common in any site examined, was not related to time in service or to percent of "standard weight," and was not associated with tachycardia in the majority of individuals examined. Measurement of skinfold thickness revealed that among individuals who were above 100 percent of "standard weight" the arm and scapular measurements customarily exceeded 10 mm.

Few other relationships exist between clinical manifestations and time in service. Yellow palms were least evident among military personnel in service for 1 to 4 years, swollen red gum papillae were most evident among those in service for 2 to 10 years, and nasolabial seborrhea was most often observed amongpersonnel in service over 10 years.

Police Cadets

The clinical findings among 130 police cadets examined in the Urban Federal District are presented in Tables 84, 85, and 86. A comparison of these individuals with the 156 military personnel examined in the Urban Federal District reveals few differences between the two groups. The abbreviated examination revealed a higher prevalence of angular scars but a lower prevalence of swollen red papillae and filiform papillary atrophy than that observed among military personnel in the Urban Federal District. All police cadets appeared to clinicians to be alert and in good physical condition.

In the detailed clinical examination, hepatomegaly and splenomegaly occurred approximately as infrequently among police cadets as among military personnel in the Urban Federal District.

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3. Perez, C., N. S. Scrimshaw and J. A. Munoz. Endemic Goiter, 1960, World Health Organization Monograph Series No. 44, Geneva, Technique of endemic goitre surveys, p. 369 and 376

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Figure 14

PERFORMANCE OF A DENTAL EXAMINATION

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DENTAL HEALTH

Introduction

There is a relative paucity of information regarding the prevalence of dental and oral diseases in most parts of the technically underdeveloped countries. The literature concerning conditions in Nigeria is very scanty. The nutrition survey of the country afforded a unique opportunity for a baseline study of dental health in Nigeria.

Materials and Methods

During this survey a total of 1,197 persons from both the civilian and military populations in the country, as classified in Table 87, received dental examinations. A United States dentist who had wide experience in dental epidemiological work in many countries spent a week with the survey team to assist in standardizing procedures for a Nigerian dentist who carried out most of the examinations. All the examinations were conducted under good natural light, using standard dental probes and mirrors, with the person being examined seated on a portable dental chair.

The parameters of the dental investigations included:

(a) The status of dental eruption and macroscopic abnormalities of the dental tissues

(b) Periodontal health and oral hygiene status

(c) Caries prevalence

The methods used are described in the ICNND Manual for Nutrition Surveys (1). For enamel hypoplasia only gross hypoplastic defects (the G type) similar to the Hy + type described by Mellanby (2) were recorded. This undoubtedly led to some underestimation of prevalence. A tooth was considered hypoplastic if it presented unmistakably grooved rings or defects of palpable depth which could be recognized by any observer.

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TABLE 87. NUMBER OF PERSONS RECEIVING DENTAL EXAMINATIONS IN NIGERIA, 1965
(Military and Civilian)

Area	Males	Females	Total
Northern Region, Civilian	62	100	162
Eastern Region, Civilian	98	90	188
Western Region, Civilian	114	91	205
Military (all Regions)	198	--	198
High Economic Class Schools (Lagos and Ibadan)	94	80	174
Poor Area Schools (Rural)	178	92	270
Total	744	453	1,197

The presence or absence of ulcerative (Vincent's) gingivo-stomatitis was also recorded, and the diagnosis was based on the triad of symptoms listed by Boyle (3):

(1) Interproximal location of the lesions
(2) Presence of truncated papillae
(3) Absence of supperation

The third symptom listed above was rather variable and inconsistent and tended to depend on the severity and extent of the lesion.

Missing teeth were excluded in the computation of caries prevalence in both the deciduous and permanent dentitions. The WHO (4) df index (decayed and filled deciduous teeth) was used for assessing caries experience in the primary teeth because of the difficulty in differentiating between a missing primary tooth, exfoliated naturally, and a missing primary tooth lost because of caries.

Water samples were collected for fluoride analysis from all the locations sampled.

Most of the persons who were given detailed clinical examinations as well as biochemical tests were also studied by the dentist. The correlation of the dental findings with the biochemical results in this group of persons will form the subject of a separate report.

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Results

The most striking dental observation during the survey was the comparative rarity of dental caries in the rural areas of the country. Table 88 shows the caries experience in the permanent dentition for the different population groups. In all the rural communities, the low df index shows no consistent relationship with age. The high rise in the df index after the age of 50, as seen in the table, is difficult to explain. Most of the caries lesions in this age group were observed in the anterior teeth, in contrast to the usual location of caries in the posterior teeth in the younger members of these rural communities. This relatively higher caries prevalence in the older age groups might well be related to the practice of tooth sharpening which is prevalent in these communities. This is done in middle adult life, and the mutilation takes the form of removal of the mesial edges of the upper central incisor teeth, presenting the appearance of an inverted "w" shaped notch in the midline. This practice, which is more prevalent in the Northern Region, is believed to be undertaken for purely esthetic reasons.

The caries incidence in the rural parts of the north, and especially in the younger age groups, is out of phase with the prevalence in the other rural communities in Nigeria (Figure 15). As illustrated in Figure 16, caries prevalence among Northern Nigerian school children is considerably higher than the figures for their counterparts in the southern regions. There is a high consumption of sticky confections in the north, which are locally manufactured from the readily available sugar cane.

The children examined in the high economic class schools showed a higher caries prevalence than their counterparts in most of the rural areas. As indicated in Table 88, the df index at age 5--9 years is 0.73, and this rises to 4.33 by the age of 15--19. This seems to point to some definite correlation between dental caries incidence and socio-economic status. Even in the rural areas, some children tend to develop more susceptibility to dental decay as they start going to school. This is observed in the df figures for the children in schools in the poorer areas. It must be mentioned, however, that the latter figures are accounted for mostly by rural school children in the north.

The findings on dental decay, on the whole, agree with earlier observations by other workers. Tabrah (5) reported on the lack of dental caries in a study of 600 inhabitants of the Ibo Village of Awo Omamma in Eastern Nigeria. Tracey (6) studied dental conditions in Northern Nigeria and noted a rise in caries in the children immediately after they started going to school and eating sugar, biscuits, and sweets.

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TABLE 88. MEAN NUMBER OF df[1/] TEETH PER PERSON BY AGE AND LOCATION FOR ALL PERSONS EXAMINED IN NIGERIA, 1965

(Males and Females Combined)

Age Group (years)	Western Region		Eastern Region		Northern Region		Military (All Regions)		Poor Area Schools (All Regions)		High Economic Class Schools	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
5- 9	78	0.12	45	0.04	20	0.75	--	--	174	0.34	106	0.73
10-14	20	0.05	19	0.10	43	1.25	155	1.26	87	0.77	50	2.64
15-19	5	0.60	20	0.15	20	2.20	52	1.09	9	3.44	3	4.33
20-29	38	0.05	51	0.90	52	0.65	106	1.32	--	--	--	--
30-39	35	0.71	22	0.82	11	0.90	21	1.40	--	--	--	--
40-49	9	1.00	16	0.75	3	0.67	4	1.50	--	--	--	--
50+	19	5.42	15	3.26	13	6.15	--	--	--	--	--	--

1/ Decayed and filled permanent teeth

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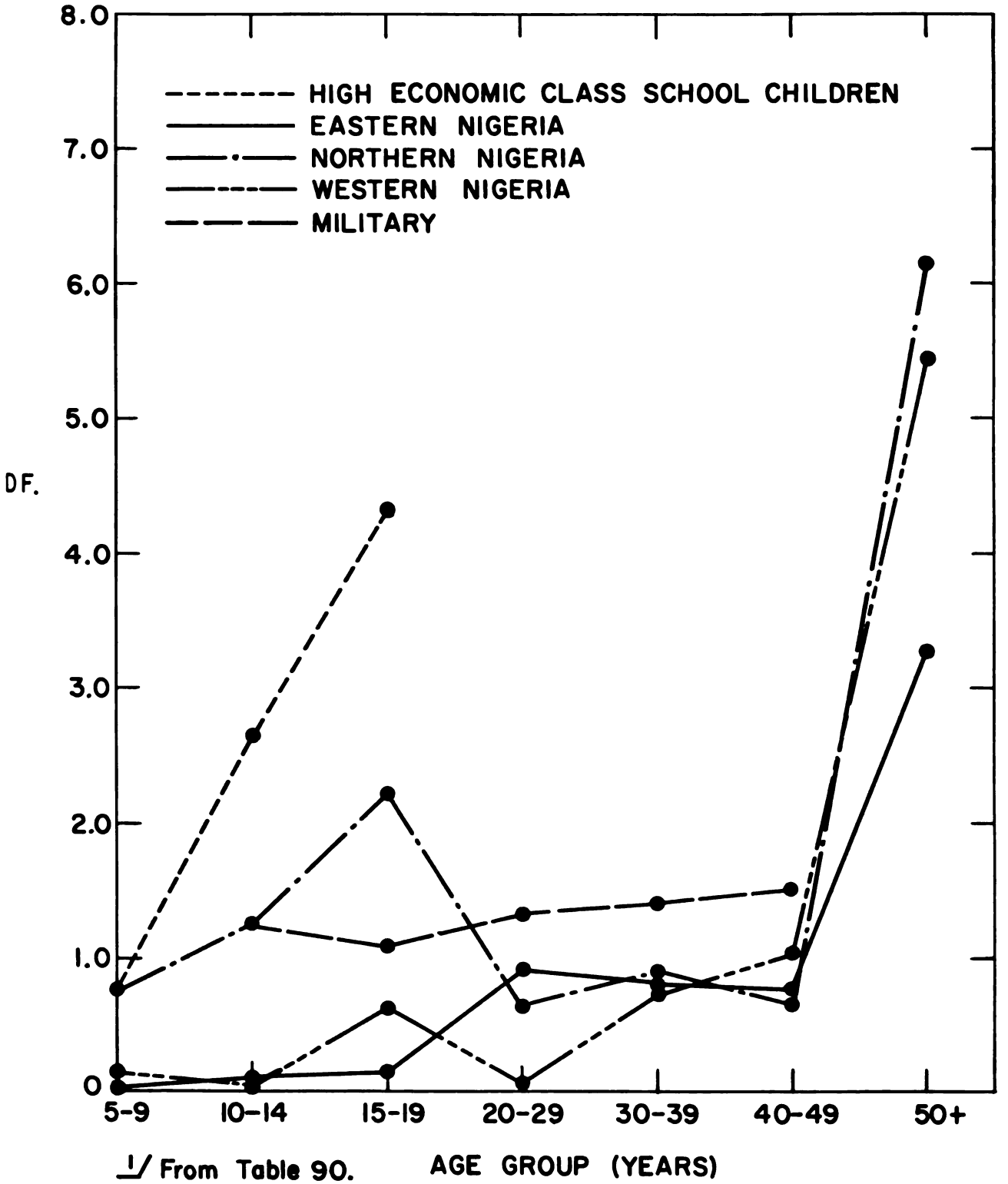
Figure 15. MEAN NUMBER OF DF TEETH PER PERSON BY AGE GROUP, NIGERIA, 1965[1/]



1/ From Table 90.

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Figure 16. MEAN NUMBER OF DECAYED AND FILLED TEETH PER PERSON BY AGE AND GEOGRAPHICAL LOCATION, COMPARED WITH FINDINGS FOR THE HIGH ECONOMIC CLASS NIGERIAN CHILDREN (MALES & FEMALES COMBINED)

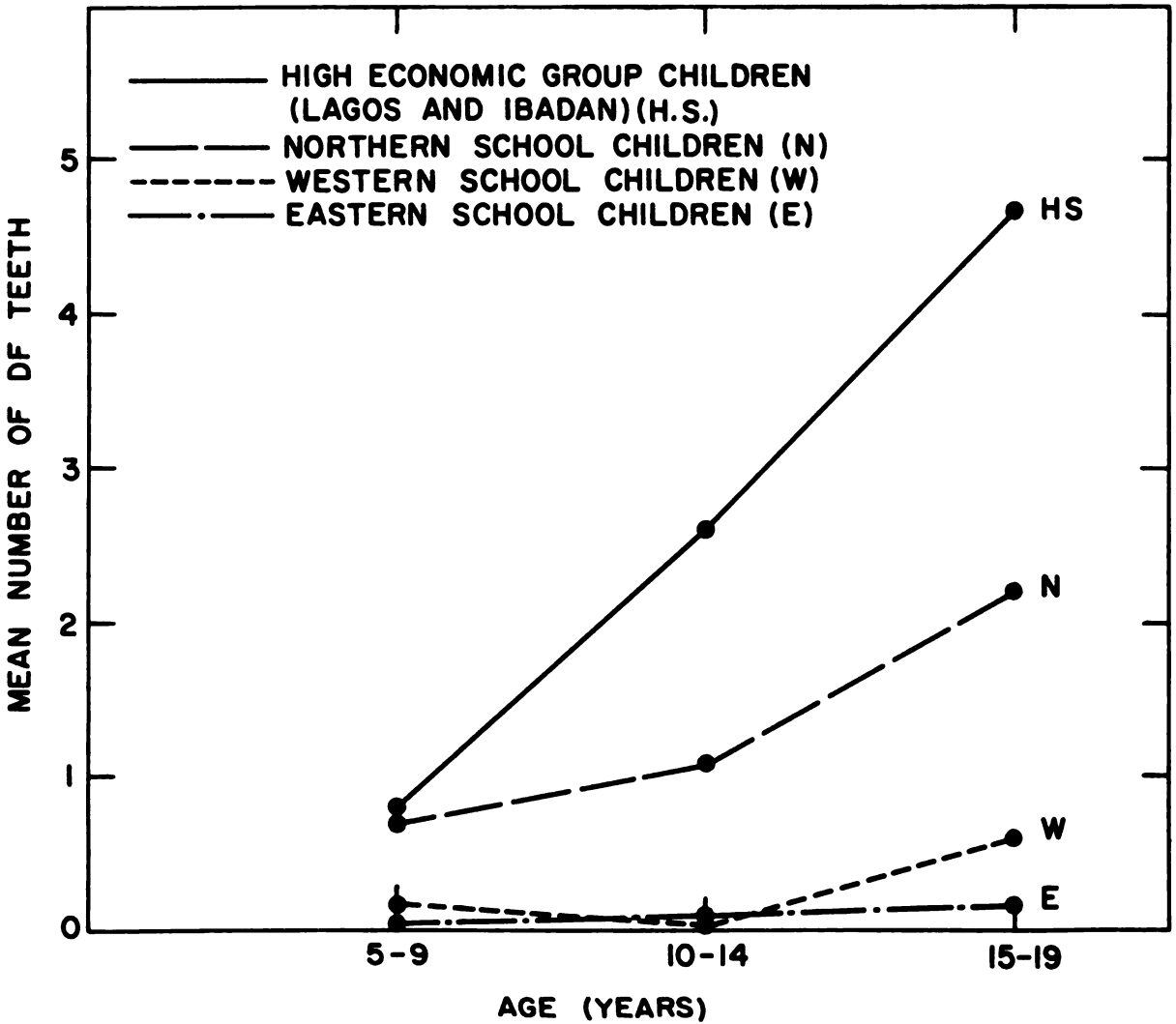

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TABLE 89. MEAN df[1/] PER PERSON, A COMPARISON OF THE HIGH ECONOMIC CLASS SCHOOLS WITH THE RURAL AREAS, NIGERIA, 1965

Males and Females Combined

Age Group (years)	Western Nigeria		Eastern Nigeria		Northern Nigeria		High Economic Class Schools	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean
0- 4	--	--	--	--	--	--	15	0.90
5- 9	78	0.33	45	0.22	20	0.85	106	1.40
10-14	--	--	--	--	--	--	50	0.38

1/ df: Decayed and filled deciduous teeth.

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The incidence of dental caries as observed in the military personnel was low, but higher than in the villages. The latter might very well be associated with their urban environment, coupled with the higher standard of living in the military population over that of the village communities.

Table 89 shows the caries prevalence in the deciduous dentitions of the 5--9 year old village children compared with the figures for the high economic class school children. In the latter group, the mean df of 0.90 at 0--4 years rises to 1.40 by the age of 5--9 years, and thereafter drops to 0.38 by the age of 10--14. This pattern agrees with the observations of Bradford and Crabb (7) on the deciduous teeth of the children of teachers in dental schools in the United Kingdom. These workers noted that the maximum number of carious cavities in any one mouth was usually reached by the age of 7 to 8 years. Figure 17 indicates that the average high economic class Nigerian child aged between 0--4 years has more dental decay than his village counterpart aged between 5--9 years.

While in the high economic group of children caries of the deciduous teeth were usually observed in the occlusal and interproximal surfaces of the posterior teeth, the incisor teeth were more frequently involved in the village children. A similar observation was made in the Osegere community of Western Nigeria by Enwonwu (8), who reported a good correlation between this pattern of dental decay and the incidence of prenatal enamel hypoplasia in this area. In village children aged 6--12 years, 8.7 percent of the deciduous teeth showed hypoplasia involving the incisal thirds of the upper and lower incisors.

The relation of caries to hypoplasia has been a controversial topic. Mellanby (2) related caries severity in 1,500 teeth to the degree of hypoplasia. Jones, Larsen, and Pritchard (9) had earlier reported on the caries-hypoplasia relationship in Hawaii and coined the term "odontoclasia" to describe the clinical condition. Davies (10) made similar observations in the remote Pacific area of Pukapuka and correlated the caries prevalence histologically with structural defects of the enamel.

Staz (11), on the other hand, reported that hypoplastic teeth were more resistant to caries than the well formed teeth. Until the precise causes of the different types of enamel hypoplasia are known, this argument will continue.

Many studies have clearly demonstrated the popularly accepted idea of caries-fluoride antagonism (McKay (12), Dean (13), Russell and Elvove (14), Brown, McLaren, and Poplove (15)). The finding of low dental caries in the Nigerian communities is unlikely to be associated with any beneficial effects due to fluoride intake. Analysis of the water samples (Table 90) showed little or no fluoride in the different areas. Table 91 indicates the percentage prevalence of the different grades of mottled enamel in the communities examined.

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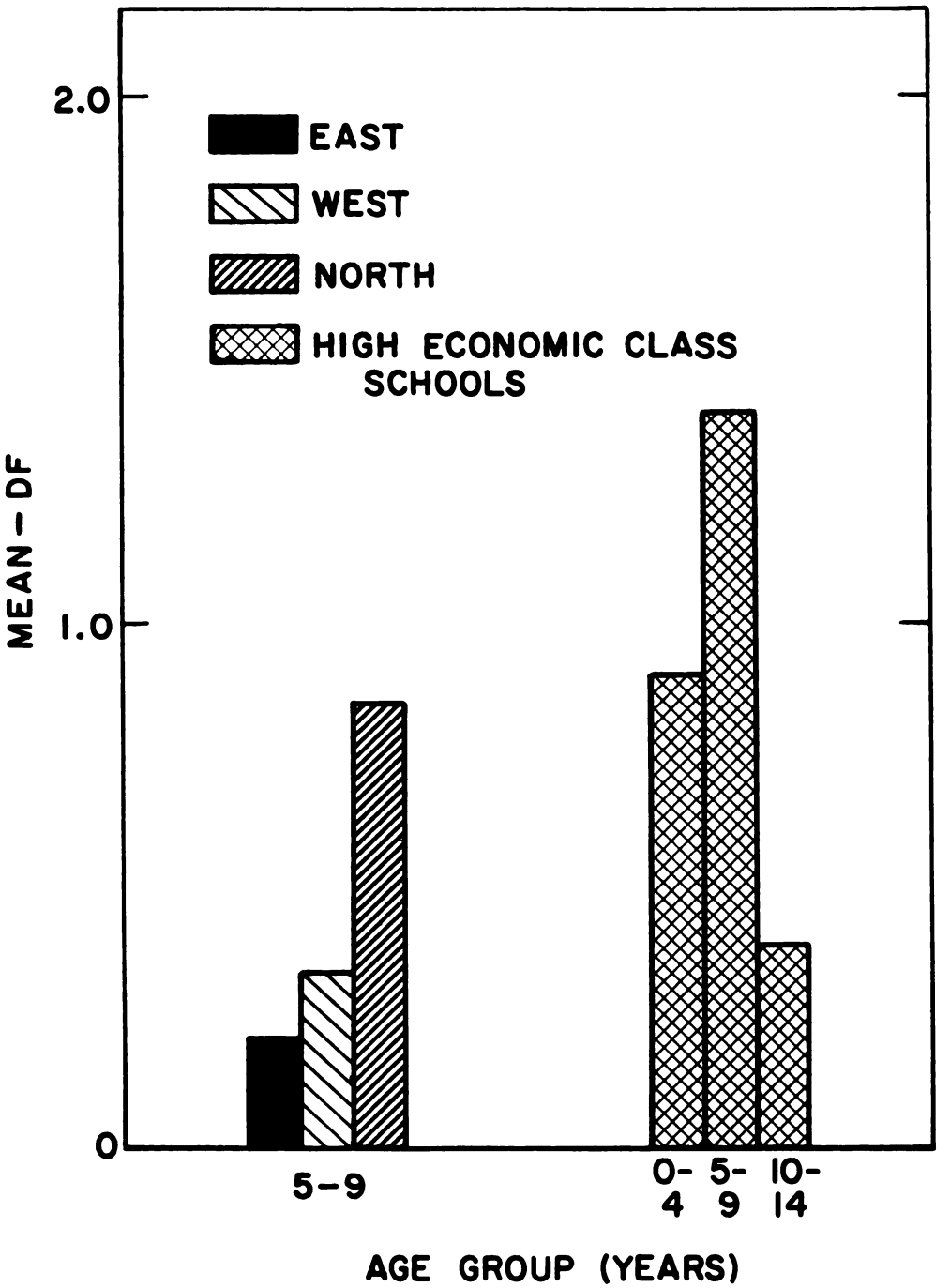
Figure 17. COMPARISON OF MEAN DF[1/] PER PERSON IN THE HIGH ECONOMIC GROUP SCHOOLS WITH FIGURES FOR CHILDREN IN THE RURAL AREAS



1/ DF: Decayed and filled deciduous teeth.

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TABLE 90. FLUORIDE CONTENT OF WATER SAMPLES COLLECTED IN NIGERIA, 196

Area		Fluoride, ppm[1/]
Northern Region	Ilorin	0.25
	Zaria	Not detectable
	Kuru, Jos	0.15
Western Region	Ibadan	0.2
	Epe	Not detectable
	Osegere	0.40
Eastern Region	Nsukka	Not detectable
	Enugu	Not detectable

1/ : parts per million

TABLE 91. OBSERVED PREVALENCE OF ENAMEL FLUOROSIS

Area or Group	Normal	Questionable	Very Mild	Mild	Moderate	Seve
			Percent Prevalence			
North	74.8	7.6	11.3	2.5	3.8	0
West	87.4	11.7	0.9	0	0	0
East	96.7	1.1	2.2	0	0	0
Military	80.2	4.1	4.1	5.6	4.5	1.
High Economic School	98.0	1.5	0.5	0	0	0

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The Northern Region of Nigeria has the highest incidence of mottled enamel. Even among the military population examined, most of the cases of mottled enamel were observed in people of Northern origin. In view of the little detectable fluoride in the water samples analyzed, it might well be that the cases of mottling observed could be attributed to other factors. A study in depth of this unusual observation is warranted. It is relevant that McClure (16) reported that the majority of foods in the average diet contain some fluoride to the level of 0.2 to 0.3 ppm or less. In addition, evidence is available that the intensity of endemic dental fluorosis depends not only on the fluoride concentrations ingested, but also on such climatic variables as temperature and relative humidity (Galagan and Lamson (17).

Another condition which has not been duly investigated is idiopathic mottling of enamel that has been observed in a low fluoride area of Maryland (18) and in the Island of Tristan da Cunha (Holloway et al (19)). The possibility of ingested substances other than fluoride resulting in mottled enamel must be considered.

Oral Hygiene and Periodontal Health

In contrast to the low caries prevalence in Nigeria, the oral hygiene as well as the health of the periodontal tissues poses a serious public health problem. This applies to military and civilians alike. Massive accumulations of oral debris and calculus were the common features encountered during the survey. It was not unusual to find a mouth with the teeth completely enveloped in heavy calculus deposits. Table 92 shows the mean periodontal index, calculus index, debris index, and oral hygiene scores per person by age in the different groups investigated. In all the population groups listed in the table, the debris index scores are quite high in the age group 5--9 years, but show a slight drop in early adult life. This drop may be due to the fact that by the age of 15--19 years, the individuals become quite adept in the use of the chewing sticks. The debris score shows a rise in late adult life when most of the teeth become mobile due to periodontal destruction, and thus lead to lack of masticatory function which aids the accumulation of debris.

The periodontal scores increase consistently with increasing age as is clearly illustrated in Figure 18. At the ages of 5--9 years the periodontal lesions in most of the rural areas are essentially inflammatory in nature. By ages 15--19, destructive periodontal lesions set in, and by age 20--29 years, most of the villagers are already approaching the terminal stages of periodontal destruction. Figure 19 and Table 93 illustrate the percentage of persons with destructive periodontal disease classified according to age and regional groupings. In both the civilian and military populations, 50 percent of the individuals between 15 and 29 years show signs of destructive lesions as determined by Russell's criteria.

Like the periodontal scores, the calculus index scores showed a fairly consistent increase with age.

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TABLE 92. MEAN PI, DI-S CI-S, AND OHI PER PERSON BY AGE GROUP FOR ALL GROUPS EXAMINED IN NIGERIA, 1965

(Males and Females Combined)

Age Group (years)	SN	N	DI-S	CI-S	OHI	PI
			Northern Nigeria			
5- 9	20	20	1.21	1.39	2.60	0.97
10-14	43	43	1.20	1.68	2.88	1.04
15-19	20	20	0.94	1.94	2.88	1.51
20-29	52	52	0.83	2.06	2.89	2.48
30-39	11	11	1.09	2.53	3.62	4.56
40-49	3	3	0.93	2.53	3.47	5.67
50+	13	13	1.16	2.68	3.54	6.49
			Western Nigeria			
5- 9	77	77	1.33	1.41	2.74	0.97
10-14	20	20	1.12	1.66	2.78	0.96
15-19	5	5	1.02	2.14	3.16	1.82
20-29	38	38	0.84	1.87	2.71	2.96
30-39	35	35	0.99	2.07	3.06	4.37
40-49	9	9	1.10	2.33	3.43	6.12
50+	19	19	1.10	2.48	3.58	6.51
			Eastern Nigeria			
5- 9	45	45	1.52	1.53	2.98	0.86
10-14	19	19	1.39	1.84	3.23	1.06
15-19	20	20	1.06	1.92	2.98	1.43
20-29	51	51	1.07	1.86	2.94	2.01
30-39	22	22	0.96	2.17	3.13	3.25
40-49	16	16	1.04	2.22	3.26	4.49
50+	15	15	1.65	2.60	4.25	5.97
			Military			
10-14	15	15	0.73	1.77	2.51	0.95
15-19	52	52	0.55	1.68	2.22	1.18
20-29	106	106	0.62	1.87	2.49	2.89
30-39	21	21	0.75	2.09	2.84	4.67
40-49	4	4	0.68	2.43	3.10	5.15
50+	--	--	--	--	--	--

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Figure 18. MEAN PERIODONTAL DISEASE SCORES BY AGE FOR PERSONS EXAMINED IN NIGERIA, 1965 (MALES AND FEMALES COMBINED)

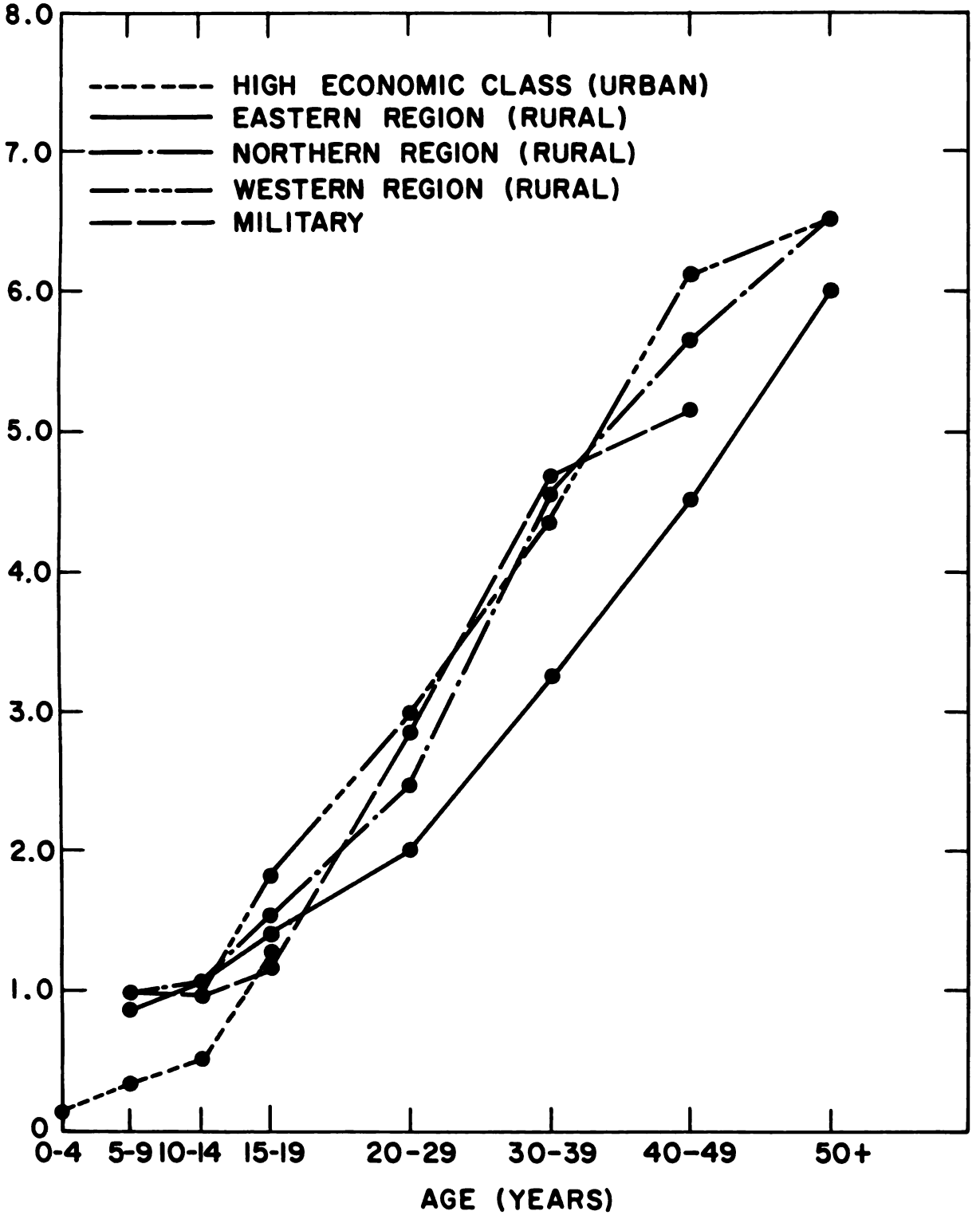

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Figure 19. PERCENTAGE OF PERSONS WITH DESTRUCTIVE PERIODONTAL DISEASE BY AGE GROUP AND REGIONS, NIGERIA

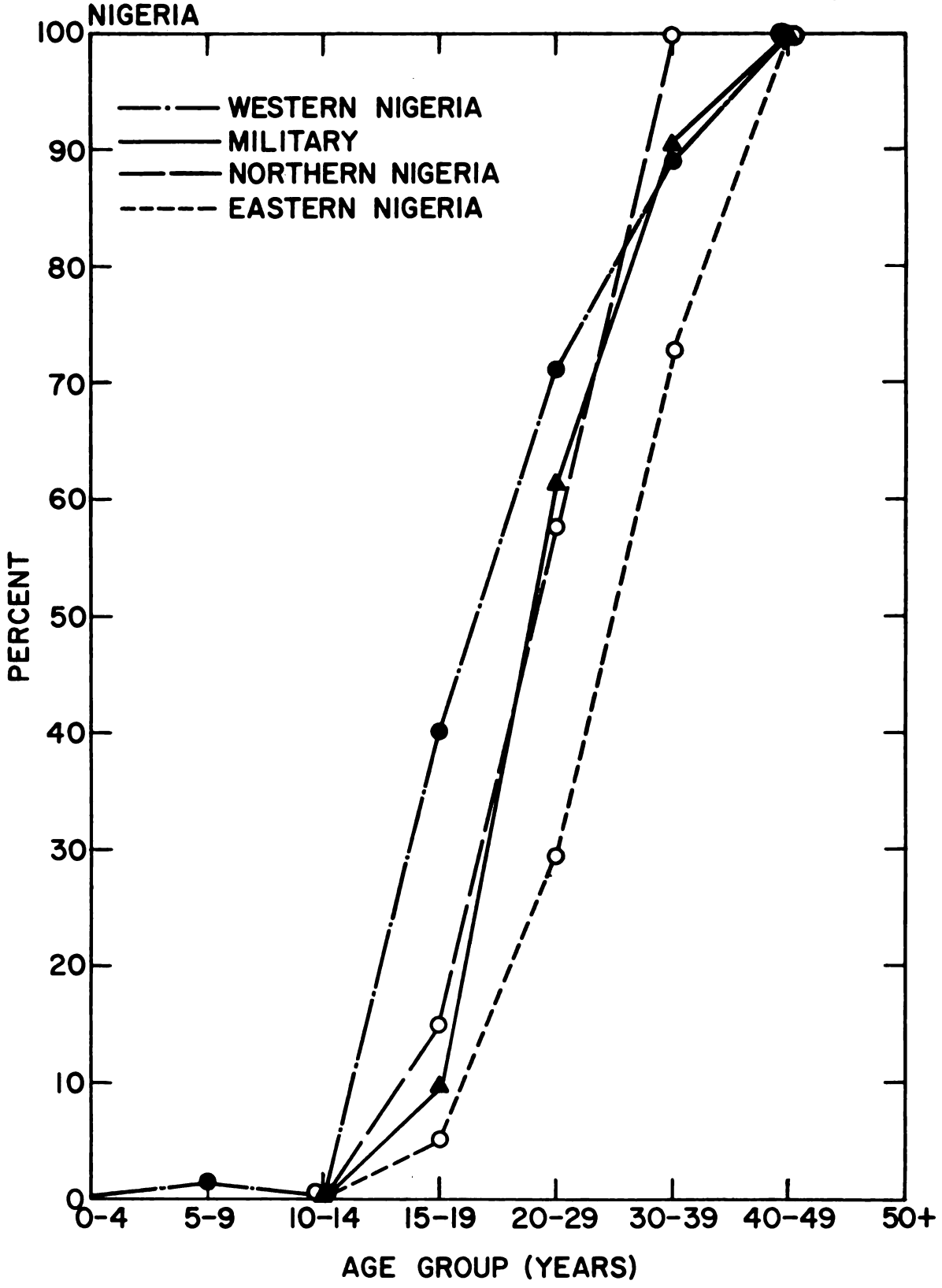

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TABLE 93. PERCENTAGE OF PERSONS WITH DESTRUCTIVE PERIODONTAL DISEASE BY AGE GROUP, MILITARY AND CIVILIAN, NIGERIA, 1965

Age Group (years)	Western Nigeria	Northern Nigeria	Eastern Nigeria	Military	Children in Poor Area Schools	Children in High Economic Schools
0-4	0.0	0.0	-	-	0.0	0.0
5-9	1.3	0.0	0.0	-	0.0	0.0
10-14	0.0	0.0	0.0	0.0	0.0	0.0
15-19	40.0	15.0	5.0	9.6	11.1	0.0
20-29	71.1	57.7	29.4	61.3	-	-
30-39	88.6	100.0	72.7	90.5	-	-
40-49	100.0	100.0	100.0	100.0	-	-
50+	100.0	100.0	100.0	-	-	-

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In Tables 94 and 95 the mean PI, DI, CI, and OHI scores for the high economic class and poor area school children, respectively, are listed. The latter group of children have more oral debris and calculus accumulations as well as higher PI values than their more privileged counterparts. An average poor area school child, aged 5--9 years, experiences a higher degree of periodontal destruction than the average high economic class young adult aged 15--19 years. Emslie (20), in a study of village children around Ibadan in Western Nigeria, recorded a PI value of 1.6 for children aged 2--5 years. This high degree of periodontal destruction in the rural communities in Nigeria is very likely related to the very poor oral hygiene status.

The observed incidence of ulcerative (Vincent's) gingivo-stomatitis in the poor area school children was 7.6 percent, and this clinical condition was encountered mainly in children aged 6--10 years. No case was seen in the more privileged group of children. Western Nigeria showed the highest prevalence of this lesion, and it is worthy of note that this is the region where the highest incidence of noma oris (perforating ulcers of the mucous membrane of cheeks and lips) has been observed (20) (8),

Cancrum (Noma) Oris

Cancrum oris is a very rare pathological condition in most parts of the world, but it is commonly encountered in Nigeria and other technically underdeveloped parts of the world. This condition has been known for centuries. WangSung and Sung (21) cited Chen Shih-Kung, a surgeon, as having described the clinical entity in his book, Orthodox Surgery (1617) as follows: "Dzo-ma-gan is a disease . . . that spreads very rapidly . . . It usually occurs after measles, smallpox, or other exanthematous diseases. . .". In this oral pathological condition, there is extensive thrombovasculitis of the afflicted tissues, and this leads to gangrene, with rapid loss of the maxilla and the mandible. Before the advent of the antibiotics, most cases of cancrum oris ended fatally, possibly as a result of the septicemia secondary to the condition (see Figure 20).

No microorganisms have been isolated as specific etiologic factors in the production of the disease. The high prevalence of cancrum oris in malnourished communities in rural Nigeria and its absence in the well fed sectors of the country are consistent with the hypothesis that it is somehow related to malnutrition. This condition has a peak age incidence in Nigeria of 2--4 years which is the period immediately following weaning in the country. It is well known that most parts of rural Nigeria have not yet devised an adequate substitute for breast milk to maintain optimal growth of the weaned child.

Predisposing factors, rather than the unknown immediate causes, are believed to play a major role in the pathogenesis and sequelae of cancrum oris. Protein malnutrition has often been suspected as a major

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TABLE 94. MEAN PI, DI-S, CI-S AND OHI BY AGE FOR CHILDREN IN THE HIGH ECONOMIC CLASS SCHOOLS IN LAGOS AND IBADAN, 1965

(Males and Females Combined)

Age Group Years	Number Examined	DI-S	CI-S	OHI-S	PI
0- 4	15	0.47	0.07	0.54	0.13
5- 9	104	0.99	0.39	1.37	0.35
10-14	50	0.76	0.76	1.52	0.50
15-19	3	1.27	1.70	2.97	1.27

TABLE 95. MEAN PI, DI-S, CI-S and OHI BY AGE FOR CHILDREN IN THE POOR AREA SCHOOLS (ALL REGIONS), NIGERIA, 1965

(Males and Females Combined)

Age Group Years	Number Examined	DI-S	CI-S	OHI-S	PI
5- 9	175	1.28	1.28	2.61	1.33
10-14	87	1.69	1.69	2.94	1.24
15-19	9	2.23	2.23	3.42	1.19

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FIGURE 20. NOMA ORIS

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contributory factor in the causation of the clinical condition, although very little research has been undertaken to support this claim. Emslie (1963) studied cancrum oris in Nigeria and suggested that systemic diseases such as measles, smallpox, malaria, and secondary anemia from infestations might be probable predisposing conditions. Linenberg, Schmitt, and Harpole (22) remarked that outstanding among the predisposing factors is malnutrition, as well as a state of lowered resistance, in addition to direct trauma to the tissues. Agnew (23) reported having not seen a case of cancrum oris in West China where obvious malnutrition did not exist. Mazumder (24) considered cancrum oris as the "most classical of all the complications of kala-azar," but added that the pathological condition was a result of lowered bodily resistance due to nutritional disorders, severe leukopenia, and anemia, rather than a direct effect by the Leishmania donovani. Jelliffe (25) reported on 53 cases of cancrum oris observed in Ibadan, West Nigeria, and said that all the children were miserably malnourished, with signs of deficiency of protein and vitamin B-complex. Many other workers have related cancrum oris to malnutrition, low socioeconomic positions, lowered tissue resistance, and debilitation, Ruben and Miller (26); Fan and Scott (27); Salama (28); Chu and Fan (29); Dawson (30); MacGregor (31); WangSung and Sung (21). It is of considerable interest that this condition has been produced by Langston (32) and by Topping and Fraser (33) in monkeys maintained on a vitamin M-deficient diet (now known to be deficient in folic acid and low in vitamin C). The latter workers provide a detailed description of the experimentally induced lesions of gingivitis, periodontal disease, and noma.

Cancrum oris is now regarded as an extension of ulcerative (Vincent's) gingivostomatitis into the contiguous tissues. Vincent's disease, like most other human diseases, can be looked upon as the result of a vigorous battle between the forces of destruction on one side and the resistance of the individual on the other. Like many other diseases, cancrum oris probably can be eliminated in Nigeria if the nutritional status of the population is raised. This belief is supported by the important observation of Agnew (23) that "Cancrum is basically an economic and social problem; it is a part of that major 'problem of the underprivileged' which lies at the very core of the present world dilemma."

Discussion and Summary

A preliminary evaluation of the variables known to affect periodontal health seems to suggest that for all the groups examined, calculus and age have the strongest link with periodontal disease. There is also evidence from the study of regression lines of CI on PI that the same amount of calculus tends to produce less damage in the mouth of a child in the high economic class school than in a child of equivalent age in the village school. These dataare being analyzed further and will be included in a more detailed report. If this greater degree of rate of change in periodontal health with each unit change in the calculus score in the poor children over the more socially privileged children is proven, it might be worthwhile investigating further the factors involved in the resistance or predisposition of periodontal tissues to destruction.

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The available evidence from this survey suggests that periodontal disease with its sequelae in the form of loss of teeth is a major dental health problem in Nigeria and should be seriously tackled by the federal and regional health authorities. Emslie (20) reported that the periodontal health of Nigerians 11 to 17 years of age is much worse than that of children of the same age group in rural India. Table 96, which is a comparative assessment of periodontal scores for the different Nigerian population groups with figures for other countries, emphasizes further the seriousness of the problem in Nigeria.

Caries incidence in Nigeria is rising steadily. This is not unexpected as the country embarks on rapid social and economic advancement. MacGregor (31) observed the same trend in Ghana.

The last few years have seen rapid changes in Nigeria. With the setting up of many industries, the people are becoming more prosperous, and the pattern of food consumption has changed radically. As noted by Bassir (34), millions of people now eat bread, biscuits, and other processed foods. Most of these refined diets have been shown to be caries-inducing. Nigeria, with a dentist/population ratio of 1/748,100 Gullett (35) is perhaps one of the worst placed countries in the world in terms of tackling the dental hazards which are often associated with the trappings of civilization. The problem becomes more serious when these dental hazards are superimposed upon those already known to be endemic in the country, and which cause widespread loss of teeth as a result of periodontal diseases.

Mottled enamel was observed in appreciable numbers of individuals. This is not correlated with high concentrations of fluoride in water, as shown by analysis. Further investigations of this phenomenon are necessary before the significance of the mottled enamel can be ascertained.

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TABLE 96. MEAN PERIODONTAL DISEASE SCORES FOR THE NIGERIAN GROUPS COMPARED WITH PUBLISHED FIGURES FOR OTHER POPULATION GROUPS

Age (yrs.)		5-9	10-14	15-19	20-29	30-39	40-49	50+
The West Indies (1961)[a]								
Trinidad	Urban	-	-	0.40	1.39	2.29	3.76	4.62
	Rural	-	-	0.45	1.76	3.28	3.96	5.51
Tobago		-	-	0.43	1.23	2.50	3.72	5.12
St. Lucia		-	-	1.29	2.57	3.44	4.90	5.92
St. Kitts		-	-	2.48	1.90	3.70	4.67	6.01
Nevis		-	-	1.23	2.80	4.91	4.90	6.06
Anguilla		-	-	1.41	2.48	4.56	6.44	5.93
Other Surveys[b]								
Alaska (1958)		-	-	0.40	0.69	1.39	1.45	1.06
Ecuador (1959)		0.12	0.29	0.38	0.41	0.89	1.43	2.34
Chile (1960)		0.14	0.26	0.34	0.67	1.13	2.09	3.51
Lebanon (1961)		-	0.24	0.32	0.54	1.75	3.02	3.95
Nigeria (1965)								
West		0.97	0.96	1.82	2.96	4.37	6.12	6.51
East		0.86	1.06	1.43	2.01	3.25	4.49	5.97
North		0.97	1.04	1.51	2.48	4.56	5.67	6.49
Military		-	0.95	1.18	2.89	4.67	5.15	-
High Economic Children		0.35	0.50	1.27	-	-	-	-
Poor Area Children		0.83	1.03	1.53	-	-	-	-

(a) Nutrition Survey (August-September, 1961), The West Indies. A Report by the Interdepartmental Committee on Nutrition for National Defense, Washington, D.C., 1962.

(b) International Nutrition Surveys: A Summary of Preliminary Dental Findings. A. L. Russell. J. Dent. Res., 42, 1 (Supplement), pp. 233-244, 1962.

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XI

INTELLECTUAL CORRELATIONS OF NUTRITIONAL AND OTHER CHARACTERISTICS OF NIGERIAN CHILDREN

Since 1956, the Interdepartmental Committee on Nutrition for National Development (ICNND) has participated in nutrition surveys in 25 developing countries. While ICNND has long recognized the need to examine learning deficiencies associated with malnutrition, the first occasion when behavioral scientists were added to a survey team was in the present survey in Nigeria during February and March 1965. This section describes the instruments used in the survey and reports on the two behavioral studies completed.

Tests of Intellectual Processes

The tests used in the survey are outlined in Appendix 15. In all, four were utilized, two at each of two levels. The first level was used for children 3, 4, and 5 years of age, the second for those from 6 to 13 years. At each level, a performance and a verbal test battery were employed. Scoring procedures were developed to make each score of approximately equal weight in order that the verbal and performance subtest scores could be summed to yield a full-scale score. No standardized scores were available. The performance tests were administered by the U.S. team member who knew only a few phrases of encouragement in Yoruba. Thus he relied largely on gestures and facial expressions to elicit responses. A Yoruba psychometric examiner was present to give verbal instruction in the regional language and to interpret. The verbal tests were given by the Nigerian psychologist on the team, who was Yoruban.

Preschool Level

Performance Test

The performance subtests were modified largely from the Ontario School Abilities Examination and the Stanford-Binet Tests of Intelligence. Some were designed expressly for the survey. The battery consisted of six subtests: (1) block building (which measures visual perception and hand-eye coordination); (2) the three-hole form board (which measures observation powers, motor coordination, memory, and the ability to improve with practice); (3) the copy-of-designs test (which is especially culturally slanted since use of pencil and paper is involved; however, it provides a measure which is quite highly related to beginning success in school); (4) alternation learning (which taps problem solving in a novel situation); (5) block designs (which measures the ability of the subjects to see patterns); and (6) sequence tapping (which measures speed of hand movement and persistence).

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The notes in Appendix 15 evaluate the usefulness of each of the subtests. As anticipated, some were quite easy and some quite hard, thereby providing a fairly wide range of difficulty. Thus, the test appeared to discriminate well among the slow, average, and bright children. The children enjoyed the "games," but the tests worked to the disadvantage of the preschool child in a remote village who had no experience with blocks, puzzles, pencils, or paper. Thus the tests were not "culturally fair;" this is not necessarily a fault, since they measure environmental differences.

Verbal Test

The verbal subtests were developed by the Nigerian psychologist member of the team and his associates at the University of Ibadan. They had been working on them for some two years before the nutrition survey of Nigeria was undertaken. Therefore, the battery had been rather well field-tested on both less-privileged and privileged Nigerian children. The five subtests included: (1) identifying parts of the body (this test worked to the advantage of the rural, unclothed child who, from an early age, had played a game between the child and the mother based on such identification); (2) identification of pictures which involved naming such common objects as hen, axe, etc.; (3) information items such as "what is your name?"; (4) action agents such as "what cries?" (which involves identifying objects from their chief action); and (5) similarities (or modified analogies) which measure higher mental processes.

Primary School Level

Performance Test

This battery of five subtests included: (1) the Seguin Form Board, a classic instrument for measuring speed of hand-eye coordination and perception; (2) the Knox Cube Memory-for-Sequences which measures digit span; (3) the alternation test given also at the preschool level; (4) a test to measure learning shift; and (5) tapping in sequence.

Verbal Test

The verbal subtests for this second level were also developed by the Nigerian team psychologist and his associates at the University of Ibadan. They included: (1) association items such as "a horse needs legs; a fish needs what?"; (2) learning pairs, which involved remembering which word went with what other word; (3) similarities such as "in what way are a cutlass and a knife alike?"; and (4) problem solving. Generally the battery had more difficult than easy items, therefore proving quite difficult for average and slow six year old children.

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Conclusion

The two test batteries of verbal and performance tests were a major outcome of the psychological study in Nigeria. They may be used in other countries with a minimum amount of alteration to conform to the local culture, or they simply may provide a point of departure. While it is very probable that the various subtest items measure different aspects of intellect, only three scores were used in this survey: (1) full-scale, (2) performance, and (3) verbal. Eventually, more refined instruments measuring a number of facets of intelligence will be needed to study in depth the effects of specific nutritional syndromes on specific behavioral and intellectual processes.

The Elite-Village Study

A wide range of cross-cultural studies on intelligence test performance exists in the psychological literature. Some workers have administered in other cultures tests which were standardized in Western cultures. Generally, children in these latter settings have understandably performed less well, since the tests were heavily biased in favor of the Western ethnic group. Furthermore, achievement motivation for games and puzzles appears to be very different for Western than for non-Western children. However, cross-cultural differences may well exist within as well as between ethnic groups.

The purpose of the present study was to compare the intellectual processes of a group of remote village (V) children in Nigeria with an elite (E) city group in that same country serving as a referent. In a real sense, this was a study of "advantaged" versus "disadvantaged" in terms of modern cultural opportunities.

Subjects

Both groups of children were preschool children of the same age, residing in Western Nigeria. The "elite" group lived in the city of Ibadan, while the "village" group lived in the village of Osegere some 30 miles away. Both samples of children were drawn from subjects being followed in a long-term growth study by Professor Edozien. Basic data are presented in Table 97 on both groups of subjects.

The elite group consisted of 17 subjects. Their mean age was 53 months, with a range from 3 years 1 month to 4 years 11 months. The group consisted of 10 boys (5 aged 4, and 5 aged 3 years) and 7 girls (5 aged 4, and 2 aged 3 years).

Many of the "elite" group attended an exclusive day-nursery school on the University of Ibadan campus where the teaching staff and pupils were racially mixed. The parents of the subjects were all Nigerians

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TABLE 97. MEANS, STANDARD DEVIATIONS, RANGES AND TESTS OF SIGNIFICANCE FOR THE IBADAN (ELITE "E") AND OSEGERE VILLAGE (VILLAGE "V") GROUPS

Variable	Group	No.	Descriptive Statistics Mean	S.D.	Range	Inferential Statistics* "t" Value	df	Probability Level (.05)
Chronological age (months)	E	17	48.41	7.64	37-59			
	V	17	48.41	7.44	37-58			
	Difference		Nil			0.00	---	---
Intelligence Test Scores								
Full Scale	E	14	49.36	11.22	25-66			
	V	16	29.37	10.07	9-48			
	Difference		+19.99			5.143**	28	2.048
Performance Scale	E	17	22.00	5.59	10-29			
	V	17	12.76	4.89	6-22			
	Difference		+ 9.24			5.126**	32	2.042
Verbal Scale	E	14	26.29	7.51	20-38			
	V	16	17.06	6.71	3-28			
	Difference		+ 9.23			3.557**	28	2.048
Height (cm)	E	17	106.84	6.03	97.3-116.0			
	V	17	96.42	7.58	85.7-108.5			
	Difference		+10.42			4.438**	32	2.042
Weight (kg)	E	17	17.71	2.04	14.20-21.26			
	V	17	14.55	2.50	11.20-18.26			
	Difference		+ 3.16			4.032**	32	2.042
Wt./Ht. Ratio	E	17	1.656	0.12	1.46-1.89			
	V	17	1.483	0.17	1.19-1.78			
	Difference		+0.173			3.459**	32	2.042
Urine Laboratory Measures								
Thiamine (B_1) µg/gm creatinine	E	15	778.13	875.01				
	V	15	1065.13	615.57				
	Difference		- 287.00			Wilcoxon Test P=0.046**		
Riboflavin (B_2) µg/gm creatinine	E	16	1662.50	1256.16				
	V	15	216.93	144.05		Wilcoxon Test P=0.001**		
	Difference		+1445.57					

*The unmatched "t" test was used, except where Wilcoxon Test values are shown.
**Significant at the 0.05 level of confidence.

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(mostly Yoruba), a large percentage of whom had spent a period of time in Europe or the United States. The fathers were on the faculty of the University of Ibadan or were senior civil servants in the Ibadan area. The families were monogamous, living in various parts of the city in Western-type homes where a combination of Nigerian and European customs were practiced. At an early age the elite children were exposed to books, radio, television, cars, pencil and paper, toys, trips, and the discourse of intellectuals. Usually both parents worked during the day, and nannies cared for the children after school hours. These nannies frequently carried the children on their backs during the first two years, but the children were weaned at about 6 months, with foods such as milk, bread, butter, and vitamin supplements appearing in their diets. Not all of the parents were Yoruba from Western Nigeria. Some were Ibo, or of other ethnic groups from different parts of Nigeria, but from families affiliated with the local University or the Government.

The sample of 17 village (V) subjects had a mean age of 53 months with a range from 3 years 1 month to 4 years 10 months. The group consisted of 9 boys (5 aged 4, and 4 aged 3 years), and 8 girls (5 aged 4, and 3 aged 3 years).

The village group resided in a farming community, the families living in polygamous compounds. The parents were unschooled. In order to reach Ibadan, the people walked on a trail to the highway and there usually obtained a ride to town on a "mammy wagon." The men engaged in farming and the women in petty trading, child rearing, and household chores. Young children were either carried on their mothers' backs, or kept at the side. Older children wandered about the compound, village, nearby woods, or plots of arable land. Children were weaned at 18 months to 3 years of age to the family fare of local foodstuffs, mainly the compound food pot and fruits in season. From birth, the children had attended a health clinic at the edge of the village. All had been monitored from birth by medical personnel. Hence, accurate birth dates were available. Although European toys, books, blocks, pencil and paper, etc., were not available to the children in their homes, from their visits to the clinic, members of the group were comfortable around chairs and desks, pencils and papers, etc.

In all, 34 subjects were thus involved, all 3 and 4 years old. The mean age for both groups was 4 years 5 months, and there were 19 boys and 15 girls. Previous research by Edozien has demonstrated that, at least through the first four years, the height and weight is not different for the sexes. Therefore, the proportion of boys and girls was not kept exactly equal, but essentially so.

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Testing

Village subjects were brought to the Osegere Village Health Center by a local boy who served as a runner. Usually the subject was accompanied by the mother, father, or older sibling who held the child on the knee while sitting in an easy chair. One half of the children were given the verbal before the performance subtests, and vice versa. In all cases, one test battery followed immediately after the other. Each took about 15 minutes to administer, including a warm-up period which consisted of stacking blocks one upon the other until they fell down. All children were rewarded at the end of each session by a piece of toffee which was thoroughly enjoyed. Parents and older siblings frequently were admonished to refrain from assisting the children and generally complied. All seemed relaxed and comfortable around the Health Clinic which was familiar to them as a place to come for help when in trouble. Neither examiner wore a white coat, which helped to allay any apprehension that a medical procedure might be in the offing. One four year old boy refused to take the verbal test, dropping the number to 16 in that category. There was generally good rapport, with the American examiner having a particularly easy time eliciting responses, because the tests were viewed as games involving the use of the hands rather than verbal response which was hard for a shy child. The children were clearly curious concerning the tests and personnel. Finally, both examiners were males, which may have helped rapport, since the female nurses at the clinic were associated with drawing blood and the giving of inoculations.

The elite group was tested either at the University of Ibadan Senior Faculty Nursery School or at the Child Development Unit on the University campus. None was accompanied by his parents. The two-thirds who were in school were simply called out of the room onto a patio to be tested. Children from home were driven to the University by a driver who knew both the children and their parents well, since he regularly had brought the children to the campus for growth measures over a period of 3 to 4 years. The same two test batteries were given in the same fashion as described for the village children.

The total village group was tested before the elite group; no counterbalance feature was employed. The performance test was given by the U.S. team member throughout; the verbal test for the elite group was administered by one of the women assistants to the Nigerian team member. The latter test was administered in English, Yoruba, or Ibo depending on the language preference of the child. Three of the elite group could not be tested because their language was not spoken by any of the examiners.

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Results

The results are presented in Table 97 and are summarized below:

(1) In terms of intellectual processes, the elite group was clearly superior to the village group on all three measures: full scale, performance, and verbal subtest scores. Differences were significant at the 0.05 level of confidence using the unmatched "t" test. Clinical impressions supported the objective evidence. The elite group generally was more facile in attacking and solving the problems, was more familiar with the types of tasks and materials employed, and was obviously more at ease. One had the impression that the village children were not performing at a comparable level to average children in the United States, but that the elite group was equal to, or superior to most U.S. children of comparable ages. Clearly, even by the age of 3 and 4, Nigerian rural children were intellectually (as measured by these tests) far behind urban elite children.

(2) In measures of height and weight, the elite group was also significantly superior to the village group. The results were closely comparable for both measures. By State University of Iowa standards (which are based on data for American children), the elite group was in the high average range in height, and the village group was below average. In weight, the elite group was average, and the village group was below average. Thus, the elite group resembled average or slightly above-average American children in height and weight.

As an index of nutriture, the relationship of Wt./Ht. x 10 was examined. By this index, crude as it may be, the urban group was superior to the rural group, the difference being statistically significant. The city children were of above-average height and weight and were well built, though not fat, while the rural children were short and thin for their ages by both American and elite Nigerian standards. A plausible explanation would be that the caloric nutriture of the elite group was above that for the rural children.

(3) In terms of vitamin nutriture as reflected by thiamine and riboflavin in the urine, the picture is more mixed. The village group was significantly higher in thiamine; the elite group in riboflavin. What was more remarkable than measures of central tendency was the variability. Some subjects, both in the elite and village groups, were very low in thiamine and/or riboflavin. But a number, especially in the elite group, were remarkably high, suggesting consumption of vitamin supplements and the urinary excretion of excesses. (The village children have access to vitamin pills through the Health Clinic, which probably accounts for the variability of urinary B-vitamin excretions among that group.) Notwithstanding, the explanation for these findings in terms of food sources is not immediately apparent.

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Discussion

The clear superiority of the elite group over the village group in intellectual processes may be due to a number of factors. Most apparent possible explanations include: (1) innate, (2) nutrition, (3) health, (4) cultural, and (5) emotional differences. All of these would appear to have some merit. At best, from this survey, one can only speculate on their relative influences. Controlled experimentation, including the assessment of the effects of deliberate dietary or nutritional interventions, will be needed to make interpretations more firm.

Innate differences cannot be discounted. The elite group was in the Nigerian upper class socially, economically, and culturally. By some selective process the families had risen to higher status and had migrated from rural areas. The rural group had been left behind in the village. This latter group, despite a very low standard of living, had not moved to the city or otherwise advanced its lot.

Nutritional differences probably play a role. The elite group was taller, heavier, and had more body fat. Generally, except for thiamine, their vitamin level was higher. They had a diet made up of both Nigerian and European foods including milk, bread, meat, butter, etc.

Health differences may have existed. The elite urban group lived in European-type homes with both excellent medical care and good sanitation. The rural children were less fortunate, although they had access to the health clinic located at the village. Nevertheless, the compounds were unsanitary, the houses had mud floors and mud walls, and the children wore no shoes and little clothing. The elite children appeared clean, well-bathed, and well-groomed; by contrast, the village children generally appeared uncared for physically.

Cultural differences probably played a very important part. The elite group was advantaged in having well-educated parents who provided the children with a wide range of cultural opportunities. The village group lived in isolated, rural conditions. The cultural differences between the two groups were striking.

Emotional differences may be a factor, though this was not apparent. The elite children lived in monogamous, while the village children lived in polygamous family settings. The latter had more brothers and sisters, were weaned later, were carried on the back of the mother, and hence were in close physical association with her. But both groups appeared well-adjusted for 3 and 4 year olds, even though the village children were much shyer, and the elite more independent. There is no reason to believe that severe enough adjustment problems existed among either group to affect test performance markedly.

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Thus, the sharp differences in intellectual capabilities would appear to be multicausative including, in unknown proportions, innate, nutritional, health, and cultural factors. None can be discounted.

Summary

The intellectual processes of a group of 17 upper-class Nigerian children in a university setting were contrasted with those of 17 lower-class rural children living in a remote village which was serviced regularly by an excellent health clinic. Ages of the subjects were 3 and 4 years. In all measures of intelligence, the elite group was superior to the village group, all differences being statistically significant. On height, weight, and weight-for-height measures, the urban sample was also superior to the rural group. For riboflavin (but not for thiamine), the urban group had a higher urine excretion level.

The described sharp differences are probably due to a complex interaction of a number of factors including innate, nutritional, health, and cultural factors. The city group lived in monogamous homes where the father was a physician, professor, or senior civil servant; the rural group was raised in polygamous compounds of unschooled parents. The elite had the joint advantages of Nigerian and European cultures, foods, and health services, while the village group lived in underdeveloped, rural, relatively unsanitary conditions on local foodstuffs.

The Riboflavin Deficiency Study

The importance of an adequate diet for both physical and intellectual development has been discussed frequently. A number of studies have been conducted aimed at providing information bearing on the question as to which nutritional deficiencies, to what degree, for what periods of time, and at what stages in the development of the organism may result in how much, if any, retardation in intellectual functioning, of what types, and of what permanence? The study presented here is exploratory and survey in nature. Its purpose was to determine if Nigerian children with observable clinical signs of vitamin B_2 (riboflavin) deficiency would be less effective in intellectual processes than a comparable group of children without such clinical signs.

The study was conducted in Epe, a Nigerian coastal town southwest of Lagos, where vitamin deficiencies were purported to be prevalent. A riboflavin deficiency was suspected clinically, and a number of reports had indicated that a central nervous system disorder of possible nutritional origin was widespread in the area.

Riboflavin is essential to proper cellular oxidation and, therefore, important for growth and function of all tissues including those of the central nervous system. Principal diet sources include milk, cheese,

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liver, and green vegetables. Clinical deficiency symptoms include angular lesions and scars at the corners of the mouth, cheilosis (edema and swelling of the lips), filiform papillary atrophy of the tongue, glossitis (inflamed) and magenta-colored tongue. Urinary excretion of less than 300 micrograms of riboflavin per gram of creatinine per day is considered to indicate a deficiency of this nutrient.

Subjects

Both groups of subjects were selected by examining the pupils in a large elementary school on the outskirts of Epe. The physicians identified 15 subjects as the experimental (E) group by consecutively screening the school population. Each had at least one clinical sign of riboflavin deficiency, e.g. lip or tongue changes. The number of signs ranged from two to four with a median of three and were rated from mild to severe. These subjects were re-examined by two physicians working as a team to verify the clinical signs.

The control (C) group consisted of 15 subjects of the same age (plus or minus 1 year), all without any clinical signs of riboflavin deficiency on either the lips or the tongue. Control subjects were chosen as the next numbered case, after an experimental one, which met the age criterion and was free of the aforementioned signs.

As shown in Table 98, ages of the children ranged from 6 to 13 years, with a mean of 7.86 for the E and 8.13 for the C subjects. Their ages are approximations, since Yoruba mothers attempt to recall the ages of their children by major social or religious events. There were no records of actual birth dates. All children were Yoruba, offspring of ordinary, polygamous, Western Nigerian parents. The school which they attended was a typical public school with limited instructional materials. The teachers were very average by Nigerian standards. Emphasis was in teaching the basic reading and arithmetic fundamentals by rote.

Testing

Both groups of subjects were tested by the same examiners using the performance and verbal tests for 6 to 13 year old childred described in Appendix 15. The performance battery was administered by the U.S. team member, while the verbal battery was given by the Nigerian team member. The order of presentation was counterbalanced. Both tests were given, one after the other, each requiring about 20 minutes to administer. Testing was done in the open air under a tree near the school. A Nigerian psychometric examiner served as interpreter in the performance testing. All subjects were rewarded with a piece of toffee at the end of each of the two testing sessions. Rapport was easily established, the children enjoying the break from the classroom. Often the noise level was distracting, but conditions were comparable for both groups who were tested randomly, cutting across both groups.

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TABLE 98. MEANS, STANDARD DEVIATIONS, RANGES AND TESTS OF SIGNIFICANCE FOR THE EXPERIMENTAL (E) AND CONTROL (C) GROUPS IN THE EPE (VITAMIN DEFICIENCY) STUDY

Variable	Group	No.	Descriptive Statistics Mean	S.D.	Range	Inferential Statistics* "t" Value	Probability Value (.05)
Chronological Age (years)	E	15	7.86	---	6-13	---	---
	C	15	8.13	---	6-12	---	---
	Difference		-0.27				
Intelligence Test Scores							
Full Scale	E	15	10.38	5.22	3.1-20.1		
	C	15	9.53	5.05	5.3-17.6		
	Difference		+ 0.85			0.498	1.70
Performance Scale	E	15	4.53	1.33	2.3-6.4		
	C	15	4.46	1.06	2.8-6.5		
	Difference		+0.07			0.150	1.70
Verbal Scale	E	15	5.85	4.22	0.8-14.0		
	C	15	5.07	3.20	1.7-12.0		
	Difference		+0.78			0.570	1.70
Height (cm)	E	15	113.60	8.98	102-127		
	C	15	3.67	9.82	102-131		
	Difference		- 0.07			0.020	1.70
Weight (kg)	E	15	20.45	3.19	15.4-26.2		
	C	15	20.72	4.31	15.1-32.0		
	Difference		- 0.27			0.195	1.70
Wt./Ht. Ratio	E	15	1.80	.17	1.51-2.14		
	C	15	1.81	.23	1.45-2.44		
	Difference		-0.01			0.081	1.70
Urine Labs							
Riboflavin (B_2) ug/gm creatinine	E	9	86.67	35.45	31-132		
	C	3	41.33	25.94	23-71		
	Difference		+45.34			---	---
Thiamine (B_1) ug/gm creatinine	E	11	304	203.18	30-746		
	C	4	339	133.41	170-472		
	Difference		- 35			---	---

* The unmatched "t" test was used throughout.
Note: None of the "t" values approached significance.

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Results

The results are outlined in Table 98. Essentially, they were negative. (1) There were no statistically significant differences in scores obtained by the groups on the tests of intelligence -- full scale, performance, or verbal. Children with clinical signs of vitamin deficiency scored just as well as those without. (2) There were no statistically significant differences between the two groups in height, weight, or weight-for-height measures. (3) Laboratory data on the urine analyses were available only for 11 of the experimental and 4 of the control subjects. Therefore, a statistical treatment was not justified. However, the differences between the groups in the actual urine content of vitamins appeared to be small. In fact, all subjects in both groups would be classified as riboflavin-deficient by the criterion of less than 300 micrograms of riboflavin per gram of creatinine in the urine, with the riboflavin content slightly lower for the control group.

Discussion

This exploratory study cannot be considered conclusive and can yield only tentative speculations. As such, they are presented here. (1) The nonsignificant differences in intelligence may be explained in a number of ways. First, perhaps, since all subjects in both groups by laboratory tests were deficient in riboflavin, this reduced substantially the chances of getting differences between the two groups. Second, perhaps there is little relationship between riboflavin deficiency and intellectual processes. Third, perhaps there is little relationship between clinical signs in a field situation and true vitamin deficiency. For unknown reasons, certain subjects may be more resistant to showing clinical signs than others. Other explanations may be feasible, including the lag between a rather sudden increase in vitamin intake and the time when the clinical signs disappear. The latter is very unlikely in the current situation, in view of the low urinary excretions. (2) The lack of significant differences in height, weight, and weight-for-height indices suggests that well-nourished and poorly-nourished subjects may not be separated sharply by the clinical signs. (3) The urinary excretion data are sparse, possibly resulting in spurious findings.

Clearly a need exists for a study of children from similar socioeconomic and cultural backgrounds where one group has a deficiency by laboratory criteria of a specific nutrient such as riboflavin, and another group has an adequate level of the nutrient. The area is a challenging one. The present study is useful in regard to the questions which it raises in the planning of such future investigations. The experience here does indicate that, by proper selection of samples and of criteria, one should be able to design investigations which would yield important information on the question of the relationship of nutriture to intellectual development.

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Summary

The intellectual processes of a group of 15 subjects with clinical signs of riboflavin deficiency were compared with a group of 15 subjects of comparable ages and cultural backgrounds without such signs. Urine samples were analyzed on 11 of the experimental and 4 of the control subjects (not sufficient volume being available on the remainder). Measures of height, weight, and weight-for-height were also obtained.

No significant differences existed between the groups on verbal, performance, or full scale intelligence test scores. The groups were comparable in height, weight, and weight-for-height. Both groups of subjects were deficient by biochemical standards in riboflavin, and there was no greater degree of such deficiency among those with oral signs than in those without.

Conclusions and Recommendations

1. It is recommended that behavioral scientists participate in future nutritional surveys. While the month of study in Nigeria can be viewed only as exploratory in nature, it did suggest that appropriate and sensitive tests can be developed. Also, there is growing acceptance of the importance of studies of the influence of nutriture on intellectual development. Such investigations present many methodological problems. However, survey studies do provide opportunities to develop instrumentation and to generate fruitful hypotheses. Furthermore, they provide a mechanism for bringing together in collaborative studies biological and behavioral scientists. Thus, surveys provide a first step in a chain of research on an important dimension of human development.

2. If behavioral scientists are to be included in future surveys, it is important that they be selected well in advance to permit time for instrument development and for the outlining of specific studies to be conducted in the developing country.

3. It is recommended that Nigeria, independently or in collaboration with outside agencies, embark on a series of controlled experiments involving the effects of specific intervention treatments with defined nutrients; for example, pretests should be obtained of the psychological processes of children with a known deficiency such as of riboflavin; the experimental group should be given the appropriate food supplement and post-tests obtained to measure differential results.

4. It is recommended that the U.S. government, or other agencies, support projects to develop more precise and appropriate psychological tests for nutritional research.

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5. Finally, it is recommended that cross-cultural studies be conducted within and among countries. A likely hypothesis that needs testing is that Nigerian children, even in remote rural areas, have unusually excellent abilities in the area of memory.

In conclusion, two major results came from the Nigerian survey. First, psychological tests were identified, sensitive enough to differentiate clearly between disadvantaged rural and advantaged urban children. This series of tests, with minimal modification, should be useful on future surveys, though, hopefully, future groups will refine the instruments and develop new ones. Second, data from an investigation of vitamin deficiency support the need for studies which distinguish degrees of depletion and allow correlations of such degrees with the psychometric parameters.

It is hoped this attempt at studying the relationship between nutritional and intellectual deficiencies will serve as a springboard to more comprehensive studies on subsequent nutrition surveys, and encourage intervention studies in Nigeria and elsewhere.

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XII

SPECIAL STUDIES

Study of Vitamin A Deficiency in Young Children

Introduction

Severe vitamin A deficiency, as evidenced by xerophthalmia, leading to irrecoverable blindness and carrying a high mortality, is one of the more prevalent of all nutritional deficiency diseases in most countries of South and East Asia, the Middle East, and parts of Latin America (1). In Africa south of the Sahara it is known to occur in certain dry cultivation steppe areas such as central Tanganyika (2), Bechuanaland (3), and the Northern Region of Nigeria (4). In those parts of west and central Africa, including the Western, Mid-Western, and Eastern Regions of Nigeria, where red palm oil, rich in the provitamin β-carotene, is the main cooking oil, it has been assumed that xerophthalmia does not occur.

However, after a year or more of breast feeding, the young child often is weaned onto a diet of maize pap, yam, or rice. With increasing urbanization and sophistication, proprietary foods or cow's milk are being used for infant feeding. Frequently these preparations are given in very dilute amounts and under unhygienic conditions. In these circumstances the weanling frequently suffers from repeated attacks of gastroenteritis, and this, together with measles and respiratory infections, is a potent precipitating factor in the development of protein-calorie malnutrition (marasmus and kwashiorkor).

The relationship between measles and eye lesions in malnourished children is of special interest. In areas where xerophthalmia is endemic, measles long has been recognized as a potent precipitating agent. A recent study in the United States (5) has shown that there are characteristic minimal corneal infiltrates in every case of measles. In the well-nourished subject, these alterations gradually disappear, leaving no residual impairment of vision. It is not unreasonable to suppose that in the malnourished child, particularly one who is vitamin A-deficient, these lesions might initiate the liquefactive process in the cornea known as keratomalacia, which is characteristic of extreme vitamin A deficiency.

In well-nourished children in Western Europe and North America, measles is now almost invariably a minor illness and hardly ever causes blindness. In Africa, by contrast, measles is a common, serious childhood disease, frequently fatal, often precipitating malnutrition, and not infrequently causing blindness.

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One other eye condition in malnourished Bantu children in South Africa, described as "malnutritional keratitis" (Blumenthal 6, 7), should be recognized. This author believes the latter syndrome differs from keratomalacia and responds to treatment with a combination of vitamin B-complex and vitamin A.

Colored photographs of the eyes of malnourished children from the Pediatrics Department of University College Hospital, Ibadan, showed corneal changes characteristic of xerophthalmia.

Methods Used

Because of time limitations and the special nature of the problem, the study was concentrated in locations where large groups of sick young children could be seen. The eyes of as many sick children as possible under the age of 5 years were examined, both in outpatient clinics and on hospital wards. Blood samples for determination of levels of vitamin A and carotenoids were obtained from as many children as possible with overt signs of malnutrition -- definite signs of either nutritional marasmus or kwashiorkor. Photographs were made of eye lesions suggestive of vitamin A deficiency. Breast milk was obtained from a representative sample of African mothers of the poorer classes for determination of its content of vitamin A and carotenoids.

Results

Examination of children in the wards of University College Hospital and Adeoyo Hospital in Ibadan revealed 2 children with marasmus with no eye lesions and one who had kwashiorkor with eye lesions. The results of the observations in the outpatient clinics are given in Table 99; those of the special clinics are given in Table 100.

TABLE 99. OBSERVATIONS ON 1,108 CHILDREN UNDER 5 YEARS OF AGE EXAMINED ON SIX CONSECUTIVE DAYS IN GENERAL PRACTICE CLINIC

Health and Eye Conditions		Number of Cases
Nutritional marasmus	no eye lesions	11
Kwashiorkor	no eye lesions	10
Xerophthalmia - xerosis conjunctivae		1
Xerophthalmia - xerosis corneae		0
Xerophthalmia - keratomalacia		0
Mucopurulent conjunctivitis		10
Measles - conjunctivitis		6
Measles - keratitis		0
Phlyctenular kerato-conjunctivitis		4
Panophthalmitis (unilateral)		1

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TABLE 100. OBSERVATIONS ON CHILDREN EXAMINED IN SPECIAL CLINICS AT UNIVERSITY COLLEGE AND ADEOYO HOSPITALS, IBADAN

Clinic	Number Examined	Remarks	Number with Eye Lesions of Possible Nutritional Etiology
Tuberculosis (children)	15	4 marasmic	0
Neurology (children)	10	--	0
Nutrition (children)	8	4 active kwashiorkor	1 early xerosis conjunctivae
Kwashiorkor (Adeoyo)	5	2 marasmus 3 kwashiorkor	0

Case Report

The patient with the eye lesions was a 2 1/2 year old female Yoruba child who had kwashiorkor related to an attack of measles. The rash of the latter was still present. She had angular stomatitis, edema of the dorsum of the feet, and wasting of the upper parts of the body.

Both corneae showed liquefactive changes with stromal infiltration characteristic of keratomalacia. The right cornea was perforated, with an iris prolapse in the 4 o'clock position midway between the limbus and the center of the cornea. A similar lesion was present on the left cornea in the 8 o'clock position. The child had not been treated with vitamin A. She died 10 hours after being seen. At a postmortem carried out 60 hours after death by the Chief Pathologist, Adeoyo Hospital, samples of the following tissues were taken for examination: liver for vitamin A and other lipids and histology, suprarenal for histologic and biochemical studies, both eyes for histologic studies, and skin for histologic study.

The levels of vitamin A and carotenoids in the liver of this child are shown below:

Vitamin A and Carotenoid Levels in Liver

Vitamin A	27 μg per gm fresh liver Ratio of ester/alcohol = 82/18
Carotenoids	13 μg per gm fresh liver (mainly B-carotene but two other bands also present)

Data from records of cases of kwashiorkor admitted to Adeoyo Hospital were made available for consultation by a pediatrician on the staff of the Hospital. The results are presented in Table 101.

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TABLE 101. CASES OF KWASHIORKOR ADMITTED TO ADEOYO HOSPITAL OCTOBER 1962 - JANUARY 1965

	Number 1/	Percentage
Total	143	
Relieved	87	60.9
Died	56	39.1
Cases associated with Measles	31	21.7
Cases associated with Keratomalacia	2	1.4

1/ Five children were recorded as having "conjunctivitis," 2 as having "sunken eyes," and one as having "glassy eyes."

As noted in Chapter VII, the biochemical results indicate very high levels of carotenoids and adequate vitamin A concentrations in serum for most subjects over the age of 5 years. Only one subject under 5 years of age showed low vitamin A values, and the carotenoids were high in the vast majority of instances (Chapter IX, Table 75).

Table 102 shows the values for total serum carotenoids obtained in Ibadan and Beirut on three samples of adult sera.

TABLE 102. CAROTENOIDS IN NORMAL ADULT SERUM SAMPLES

Location	Ibadan		Beirut		Beirut
Method Used	Macro Method(Carr-Price)		Micro Method(Pearson)		After Passing Through Micro Column
Sample No.	Carotenoids	Vitamin A	Carotenoids	Vitamin A	Vitamin A
	µg	µg	µg	µg	µg
1	597	3.7	1,496	36	79
2	644	7.9	630	30	64
3	607	11.1	555	65	Insufficient

Blood was taken by finger prick from 12 malnourished children, 9 with kwashiorkor, one who was marasmic with kwashiorkor, and 2 with marasmus. The eyes of all were normal. Results are shown in Table 103.

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TABLE 103. CAROTENOID AND VITAMIN A LEVELS IN BLOOD SAMPLES FROM MALNOURISHED CHILDREN

Patient, Location and Date Seen	Sex	Age (years)	Diagnosis	Micro Method (Pearson) Carotenoids µg per 100 ml	Micro Method (Pearson) Vitamin A µg per 100 ml
General Practice Clinic 1/3/65 No. 1	M	2	Kwashiorkor	46	0
" " No. 2	M	1 3/12	"	41	8
" 25/2/65 No. 1	M	1 2/2/12	"	16	0
	M	2	"	82	17
Nutrition Clinic No. 1	M	3	"		insufficient
" No. 2	F	4	"	143	17
" No. 3	F	2 1/2	"	82	9
" No. 4	F	3	"	49	0
	F	3	Marasmus	57	0
General Practice Clinic 26/2/65 No. 1	F	3	Kwashiorkor	56	2
" No. 2	M	8/12	Marasmus	33	0
" No. 3	F	2	Marasmic-kwashiorkor		insufficient
" No. 4					
"					

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TABLE 104. LEVELS OF CAROTENOIDS AND VITAMIN A IN BREAST MILK OF NURSING MOTHERS

Sample No.	Age of Children (months)	Carotenoids μg per 100 ml	Vitamin A μg per 100 ml
1	1/2	139	28
2	1	66	52
3	12	15	43
4	6	33	19
5	7	50	40
6	9	121	30
7	4	69	24
8	9	21	8
9	18	198	80
10	4	29	55
11	7	99	33
12	1	74	18
13	8	99	60
14	3	196	73
15	2	125	30
16	2	40	21
17	11	62	24
18	12	186	13
19	8	75	52
20	3	78	76
21	1	119	2
22	12	40	23
23	4	357	94
24	12	81	89
Mean		98.8	41.1
S.D.		76.2	26.3

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While none of these severely malnourished children showed eye lesions, most of them had grossly deficient levels of vitamin A and are judged to have been suffering from depletion of vitamin A. They could be expected to develop clinical signs of such deficiency in the event of any extended deprivation or stress of intercurrent disease.

Analysis of Mother's Milk

Breast milk for analysis of levels of vitamin A and carotenoids was obtained from 24 nursing mothers in the General Practice Clinic. The results of the analyses are shown in Table 104. The nursing children ranged from 1 month to 18 months of age.

Values for both carotenoids and vitamin A in breast milk varied greatly. The vitamin A levels are similar to those reported for Europe and North America. The carotenoid values are also similar to those found in Western women and are not greatly or consistently raised as is the case with the serum, indicating that there is some barrier to passage of carotenoids from serum to the breast. There was no consistent relationship between duration of breast feeding and carotenoid or vitamin A concentration in breast milk.

Judged by this sample, it seems that breast milk from most Yoruba mothers provides a rich source of vitamin A for the child during the first 18 months of life. Under circumstances that lead to kwashiorkor and marasmus, however, vitamin A deficiency may develop.

Comments on Methodologic Comparisons

The micro column devised in The American University of Beirut laboratories (8) separates carotenoids which are not all β-carotene, and allows a direct reading of vitamin A. Table 102 shows that much lower values for vitamin A are obtained by the antimony trichloride (Carr-Price) method than by the trifluoroacetic acid method of Pearson. This might be due to a much greater depressing effect of high carotenoids on vitamin A values with the antimony trichloride than with the trifluoracetic acid method.

It is of considerable interest that fractionation of the vitamin A in the two hypercarotenemic samples 1 and 2 showed a great increase in the proportion of the ester fraction. In sera other than those taken immediately after a fatty meal, this is usually not greater than 5 or 10 percent, the rest being alcohol. In these two samples, the ester fraction was as high as 54 and 47 percent, respectively.

Comments

In Nigeria vitamin A deficiency is of uncommon occurrence. Where red palm oil is consumed (a much wider area than where it is grown, as it is transported considerable distances) avitaminosis A is almost entirely

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confined to the preweaning group which does not receive red palm oil. Adequately breast-fed and reasonably supplemented children will not get protein malnutrition or vitamin A deficiency. Table 103 shows that severely protein-malnourished children, even without eye lesions of vitamin A deficiency, tend to be depleted of the vitamin.

The role of measles in the eye lesions needs further investigation. In Nigeria many children with measles develop no macroscopic corneal changes, and not all become malnourished. The child reported in detail here had liver stores of vitamin A high enough to rule out keratomalacia, unless there was failure in the transport of the vitamin by the serum protein. Transport could not be tested in the case in question. Histologic examination of the eyes will show whether the changes are those of keratomalacia or not. This case is suggestive of Blumenthal's malnutritional keratitis, which some other workers have attributed to measles, but the data are too few for definitive diagnosis.

Recommendations

1. Ophthalmologists, pediatricians, and general physicians in Nigeria should be advised that:

a. There is a danger of vitamin A deficiency developing in preschool children in areas where red palm oil is not consumed and in preweanling children, even where it is consumed.

b. Malnourished children who have any of the symptoms of kwashiorkor or nutritional marasmus tend to become biochemically depleted of vitamin A, even though, clinically, their eyes may appear normal. Prophylaxis with red palm oil, cod liver oil, or some other readily available source of vitamin A should be part of the management of such children.

c. As has been shown elsewhere, including other parts of Africa, the corneal complications of measles are frequently due to keratomalacia. From the practical point of view, it is safest to assume that they are all due to this condition, and it is advisable to give large doses of vitamin A palmitate (preferably in water-soluble form) by mouth or intramuscular injection. A dose of 10,000 I.U. per kg of body weight per day for 3 days by each route, followed by half this dose daily until no further response is obtained, is recommended.

2. The interrelations of the "kwashiorkor-vitamin A deficiency-corneal lesions in measles-complex" could very well be elucidated by further studies at Ibadan where the case material occurs. Laboratory facilities, competent clinicians, and laboratory workers are available.

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APPENDIXES

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APPENDIX TABLE 1 . SOME PLANTS GATHERED FOR FOOD IN NIGERIA [1/]

Common Name	Hausa Name	Scientific Name	Food Uses
Trees			
Locust bean	Dorawa	Parkii biglobosa, P. filicoidea	Seed: Fermented and used as a condiment. Pulp: Mixed in beverages, dried and powdered and used in porridge.
Sheabutter tree	Kade	Butyrospermum parkii	Seed: Oil extracted and used in soups. Pericarp: Fermented when green and eaten or eaten directly when ripe.
Tamarinds	Tsamiya	Tamarindus indicus	Pulp and Seed: Eaten with other foods in many ways.
Black plum	Dunya	Vitex cienkowskii	Fruit and Fruit Juice: Juice concentrated to "molasses" and used with other fruits. Young shoots: Used as pot herb.
Mango	Mangwaro	Irvingia gabonengis	Fruit
African fan palm	Giginya	Borassus aethiopum	Sap: Palm wine. Terminal bud: Salad and cooked vegetable. Seed and Fruit: Oil. Young shoots: Vegetable
Gingerbread palm	Goriba	Hyphaene thebaica	Pericarp
Date	Dabino	Phoenix dactylifera	Pericarp
Pawpaw (papaya)	Gwanda	Carica papaya	Fruit Flower: In soups
Horse radish tree	Zogallagandi	Moringa pterygosperma	Leaves and flowers: In soups and salad.
	Danya	Sclerocarya birrea	Fruit: Raw and fermented. Similar to Mango. Leaves: As vegetable
	Alilliba	Cordia abyssinica	Fruit: fresh
Mimosa	Gaude	Acacia arabica	Food use: (used in dying and tanning)
Tallow tree	Taura	Detarium senegalense	Fruit: Dried

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APPENDIX TABLE 1. SOME PLANTS GATHERED FOR FOOD IN NIGERIA[1/] (continued)

Common Name	Hausa Name	Scientific Name	Food Uses
Trees			
Orange	Lemu	Citrus aurantium	
Figs of various kinds	Baure	Ficus spp.	
Ilorin balsam	Maje	Daniellia oliveri	Young leaves: Eaten in times of famine
Monkey guava	Kanya	Diospyros mespiliformis	Fruit: Fresh, in sweets and dried (=Baro)
	Malleruwa		
Forest groundnut	Gunderu	Pterocarpus santalinoides	Seed: Roasted and eaten in time of scarcity
Vegetables, etc.			
	Aliyatto		
Red Sorrel	Yakuwa	Hibiscus sabdariffa	Leaf: Pot herb. Calyx: Fresh and dried as pot herb and relish. Seed: In soup after roasting.
(used loosely for this plant and sesame)	Karkashi	Ceratotheca sesamoides	Seeds and Leaves: Used as is sesame, except oil not extracted from seed.
	Ya'diya	Leptadenia lancifolia	Leaves, Young Shoots, Flowers: In soups
a "rubber vine"	Chiwo	Landolphia florida & L. owariensis	Fruit
	Labsur	Lepidum sativum	Young Shoots
	Tattasai		

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APPENDIX TABLE 1. SOME PLANTS GATHERED FOR FOOD IN NIGERIA [1/] (continued)

Common Name	Hausa Name	Scientific Name	Food Uses
Vegetables, etc.			
	Atarugu		
Ginger	Chitta	Zingiber officinale	
Jew mallow	Lalo Malafiya	Corchorus olitorius	Pot herb
	Yam'bururu	Merremia augustifolia	Root: Medicinal"confers immunity against scorpin sting for 1 year."
Sword lily, cornflag	Rumana	Gladiolus spp.	Small corns: In soups
(Hausa potato)	Rizga	Coleus dazo	Tubers (sometimes cultivated)
(Hausa potato)	Tumuku	Coleus dysentericus	Tubers (cultivated)
Bambara groundnut	Gurjiya	Voandezia subterrana	Used as peanut (usually cultivated)
	Akwalu	(Trochomeria)	
Foetid cassia	Tafasa	Cassia fora	Young leaves: Vegetable.
	Shuwaka		
Balsam apple	Garahuni	Mormodica balsamina	Leaves and Fruit: In soups (mostly medicinal)..
Banana-plantain	Ayaba	Musa spp.	
African mistletoe	Kanchi	Loranthus spp.	Mostly medicinal and magic.
	Dafara	Cissus populnea	Fruit: (Grape-like) in soups.

1/ The Hausa names and the uses of these plants were supplied by Mallam Ibrahim and the common names by Mallam Mande, both of whom were associated with D. L. Curtis, Botanist, Agricultural Research Institute, Samaru, Northern Nigeria. Scientific names and identification were verified where possible by reference to: J. M. Dalziel, "The Useful Plants of West Africa". Crown Agents for the Colonies, London S. W. I. 1948.

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APPENDIX TABLE 2. ADDITIONAL PLANTS GATHERED FOR FOOD (NIGERIA) 1/

Common Name	Hausa Name 2/	Scientific Name	Food Uses
Coco nut	Kwakwar attagara	Cocos nucifera	Milk, Dried nut (copra), Oil.
Tiger nut, Earth almond	A-ya	Cypernus esculentus	Seed: Raw, roasted, fermented
Hemp hibiscus	Rama	Hibiscus cannabinus	Leaf: Fresh
Nettle tree	Dukki, Zuwo	Celtis intergrifolius	
Cadaba	Bagayi	Cadaba farinosa	Leaves, Shoots. Seeds: as cereal
Bitter leaf	Shiwaka	Veronia amygdalina	
Gardenia	Gaude	Gardenia erubescens	Fruit: Raw
Christ's thorn	Kurna	Zizyphus spina-christi	Fruit: Raw
Jujube	Magariya	Zizyphus Jujube	Fruit: Raw
Guava	Guava	Psidium guajava	Fruit: Raw
Cape Gooseberry	Matsarmama	Physalis peruviana	(Medicine)
Jamaica plum	Tsadar	Spondias lutea	Fruit: Raw
Blood plum	Tursujo	Haematostaphis barteri	
Kaffir orange	Kokiya	Strychnos spinosa	Fruit

1/ Information supplied by Mr. D. L. Curtis, Botanist, Agricultural Research Institute, Samaru, Northern Nigeria (Information not verified).

2/ Probably varies.

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APPENDIX TABLE 2. (Continued) ADDITIONAL PLANTS GATHERED FOR FOOD (Nigeria)

Common Name	Hausa Name	Scientific Name	Food Uses
Trees			
	Malmo	Syzygium guineense	Fruit
Wild olive, seaside plum	Tsada	Ximenia americana	Fruit: Used in preserves. Acid taste
	Lukuki		
	Cizaki or Chizaki	Carissa edulis	Berries: Raw. Root: In soups-"covers odors."
Baobab, monkey bread	Kuka	Adansonia digitata	Pulp and seeds: In many ways. "Dandare" made from pulp. Leaves: Fresh or dried and powdered, in soups.
Kapok, silk cotton tree	Rimi	Ceiba pentandra	Seed: pressed for oil (17-25 percent), dried and powdered for soup.
	Ungududu	Crataeva adansonii	Leaves: Occasionally in soup. Fruit: Occasionally eaten.
Fig	Durumi	Ficus polita and other spp.	Fruit: Inferior to good. Juice sucked or fruit eaten.
(Several trees designated by single Hausa term)	Gwanja Kusa	1. Parinara curatellaefolia 2. P. polyandra 3. Trichilia emetica 4. Blighia sapida	1. Fruit and Kernel: Eaten Leaves: Chewed. Shoots: Chewing sticks 2. Leaves: Only. 3. Fruit: Pulp. 4. Seeds: Raw and roasted
Kola nut	Goro	Cola spp.	
African or Guinea peach	Tafashiya	Sarcocephalus esculentus	Fruit: Sometimes dried and stored.

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APPENDIX 3. METHODS USED TO DETERMINE PRESENCE OF AFLATOXINS IN FOODS

Samples of slurry-like consistency (food composites, soups, etc.) were treated as follows:

1. Sample volume measured and absolute methanol added in ratio of 3:2 volume for volume.

2. Methanol-food mixture blended in Waring blender for 5 minutes at "low" speed.

3. Total suspension-solution centrifuged at 6,000 rpm for 5 minutes. All available supernate solution decanted and saved. Compacted solids discarded.

4. Methanol-water supernate extracted with 1/2 volume of petroleum ether followed by two 1/4 volume extractions.

5. Methanol-water supernate evaporated to 1/2 volume on steam bath and extracted with chloroform 1/2 volume for 30 minutes followed by two 1/4 volumes for 30 minutes each. Chloroform extracts pooled, evaporated to near dryness. Residues transferred quantitatively to 4 dram vials and evaporated to dry film (vials later sealed with No. 00 plastic stoppers as well as bakelite caps). Dry residues held at 4° C until qualitative test for aflatoxin was made.

6. Residues dissolved in 2 ml of chloroform just prior to qualitative tests for aflatoxin on silicagel G thin layer plates. Forty μl of each sample solution spotted on 0.3 mm thick adsorbent using 50 μl capacity syringe with modified fixed needle.

7. Plates first developed in anhydrous ethyl ether, dried and observed under long-wave ultraviolet light for low R_f blue or green fluorescent material near site of application.

8. Plate then developed 10 cm (ascending technic) in saturated chamber containing 5 percent methanol in chloroform. Control solutions also spotted consisted of dilute solutions of aflatoxin B_1 and a mixture of aflatoxins B_1, B_2, G_1, and G_2. After drying, plates viewed under long-wave ultraviolet light. Sample spots with blue or green fluorescence compared in R_f value with those of the aflatoxin controls. Note: In doubtful cases, the original site of application was overlaid with aflatoxin mixture or with the appropriate single component in question. The plate was then developed as before, and the identity or nonidentity of the sample material to aflatoxin confirmed.

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Where the qualitative thin layer determination of aflatoxin was obscured by excessive impurities in the crude extract, it was necessary to resort to a small silica gel column chromatographic separation (clean up) and elution of the aflatoxin. Following this procedure, the aflatoxin spots were much more vivid on developed thin layer plates.

9. Samples giving positive qualitative tests were then quantitated for aflatoxin B (B_1 and B_2) and G (G_1 and G_2) by the method of Nabney and Nesbitt (18) using a Beckman DU spectrophotometer to measure absorbance at 420 mμ and 363 mμ in methanol. Optical density measurement at 363 mμ minus the value at 420 mμ was used to calculate B and G aflatoxin content employing extinction coefficients of 22,000 for B and 18,700 for G.

Dry Food Samples

Dry foods were weighed and extracted for six hours or more with petroleum ether in a Soxhlet apparatus followed by a similar extraction using methanol. The methanolic extract was diluted with water and extracted three times with chloroform as described above. The remainder of the process was identical to the method for slurry-like foods.

Urine Composites

The three urine composites were extracted directly with chloroform using 1/2 volume, 1/4 volume, and 1/4 volume for 30 minutes each.

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APPENDIX TABLE 4 . SUGGESTED GUIDE TO INTERPRETATION OF NUTRIENT INTAKE DATA 1/

	"Deficient"	"Low"	"Acceptable"	"High"
Protein, gm/kg body weight	<0.5	0.5-0.9	1.0-1.4	≥1.5
Calcium, gm/day	<0.3	0.30-0.39	0.4-0.7	≥0.8
Iron, mg/day	<6	6-8	9-11	≥12
Vitamin A, IU/day	<2,000	2,000-3,499	3,500-4,999	≥5,000
Ascorbic acid, mg/day	<10	10-29	30-49	≥50
Thiamine, mg/1,000 Calories	<0.2	0.20-0.29	0.3-0.4	≥0.5
Riboflavin, mg/day	<0.7	0.7-1.1	1.2-1.4	≥1.5
Niacin, mg/day	<5	5-9	10-14	≥15

1/ Suggested levels for 25 year old, physically active males.

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APPENDIX TABLE 5. MINERALS IN WATER SAMPLES, NIGERIA

Location	Total Iodine µg/100 ml	Calcium mg/liter	Fluoride ppm[1/]
4th Battalion, Ibadan	2.00	2.4	0.2
Osegere Village, Ibadan	3.15	0.6	0.40
Ballah Village, Ilorin	1.70	3.4	0.25
NMS School, Zaria	0.34	10.8	None detectable
Epe Village	0.72	2.0	None detectable
Asaba (Town), spring	0.10	0.4	None detectable
Ibusa, Asaba, stream	0.14	3.2	None detectable
Ibusa, Asaba	0.32	0.4	None detectable
Kuru, Jos	0.16	0.2	0.15
Kuru, Jos, well water	1.85	0.1	None detectable
Watz Kuru Village	0.14	0.1	0.1
Nsukka Village, Enugu	0.24	1.6	None detectable

1/ Parts per million

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APPENDIX TABLE 6 . BIOCHEMICAL FINDINGS BY SEX AND AGE, NIGERIA

	Males						Nonpregnant, Nonlactating Females						Pregnant or Lactating
	Age in Years						Age in Years						
	5-14	15-24	25-34	35-44	45+	Total	5-14	15-24	25-34	35-44	45+	Total	All Ages
Total Plasma Protein No.	107	55	22	23	20	227	76	11	10	7	13	117	124
gm/100 ml Mean	7.55	7.67	7.63	7.39	7.48	7.57	7.59	7.71	7.44	7.30	7.84	7.60	7.09
	Percent Distribution												
<6.0 "Deficient"	-	1.8	-	-	-	0.4	-	-	-	-	-	-	-
6.0-6.4 "Low"	1.9	-	-	8.7	-	1.8	-	-	10.0	-	-	0.9	11.3
6.5-6.9 "Acceptable"	10.3	1.8	13.6	8.7	15.0	8.8	7.9	9.1	20.0	14.3	7.7	9.4	35.5
≥7.0 "High"	87.9	96.4	86.4	82.6	85.0	89.0	92.1	90.9	70.0	85.7	92.3	89.7	53.2
Plasma Albumin No.	107	54	20	22	19	222	75	11	10	7	13	116	123
gm/100 ml Mean	3.39	3.69	3.56	3.44	3.28	3.48	3.44	3.45	3.32	3.47	3.31	3.42	2.97
	Percent Distribution												
<2.8 "Deficient"	13.1	3.7	5.0	4.5	26.3	10.3	8.0	9.1	10.0	-	7.7	7.8	35.0
2.8-3.4 "Low"	35.5	24.1	45.0	54.5	36.8	35.6	45.3	36.4	60.0	28.6	53.8	45.7	44.7
3.5-4.2 "Acceptable"	50.5	61.1	40.0	40.9	31.6	49.6	41.3	45.5	20.0	71.4	38.5	41.4	19.5
≥4.3 "High"	0.9	11.1	10.0	-	5.3	4.5	5.3	9.1	10.0	-	-	5.2	0.8
Plasma Globulin No.	107	54	19	22	19	221	75	11	10	7	13	116	123
gm/100 ml Mean	4.19	3.95	4.16	3.94	4.18	4.11	4.15	4.28	4.14	3.82	4.54	4.18	4.12
	Percent Distribution												
1.0-1.9 "Deficient"	-	1.9	-	-	-	0.5	-	-	-	-	-	-	-
2.0-2.9 "Low"	0.9	1.7	-	4.5	5.3	1.8	2.7	-	-	-	-	1.7	2.4
3.0-3.5 "Acceptable"	15.9	18.5	31.6	27.3	5.3	18.1	21.3	18.2	40.0	28.6	-	20.7	15.4
≥3.5 "High"	83.2	77.8	68.4	68.2	89.5	79.6	76.0	81.8	60.0	71.4	100.0	77.6	82.1
A/G ratio No.	107	54	19	22	19	221	75	11	10	7	13	116	123
Mean	0.83	0.99	0.90	0.92	0.84	0.89	0.87	0.83	0.86	0.92	0.74	0.85	0.75
	Percent Distribution												
<0.5	0.9	-	5.3	-	10.5	1.8	5.3	-	-	-	7.7	4.3	11.4
0.5-0.9	77.6	57.4	57.9	72.7	68.4	69.7	64.0	72.7	70.0	57.1	92.3	68.1	77.2
1.0-1.4	21.5	40.7	36.8	27.3	15.8	27.6	29.3	27.3	30.0	42.9	-	26.7	10.6
1.5-1.9	-	-	-	-	5.3	0.5	1.3	-	-	-	-	0.9	0.8
≥2.0	-	1.9	-	-	-	0.5	-	-	-	-	-	-	-

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APPENDIX TABLE 6. BIOCHEMICAL FINDINGS BY SEX AND AGE, NIGERIA (continued)

		Males						Nonpregnant, Nonlactating Females						Pregnant or Lactating
		Age in Years						Age in Years						
		5-14	15-24	25-34	35-44	45+	Total	5-14	15-24	25-34	35-44	45+	Total	All Ages
Hemoglobin	No.	114	58	22	25	18	237	78	12	11	6	12	119	124
gm/100 ml	Mean	11.8	13.4	14.1	13.3	12.9	12.6	11.6	11.6	12.0	12.8	12.2	11.8	10.9
		Percent Distribution												
"Deficient"		11.4	12.1	9.1	12.0	33.3	13.1	9.0	16.7	9.1	-	8.3	9.2	24.2
"Low"		15.8	55.2	40.9	64.0	38.9	34.6	21.8	16.7	18.2	-	8.3	18.5	29.0
"Acceptable"		29.8	24.1	31.8	20.0	16.7	26.6	29.5	66.7	63.6	66.7	66.7	42.0	46.0
"High"		43.0	8.6	18.2	4.0	11.1	25.7	39.7	-	7.1	33.3	16.7	30.3	0.8
Hematocrit	No.	114	55	22	25	18	234	78	12	11	6	12	119	124
Percent	Mean	37.0	42.9	43.7	41.7	41.7	39.9	36.5	37.0	37.4	40.7	38.0	37.0	35.0
		Percent Distribution												
"Deficient"		2.6	-	4.5	12.0	5.6	3.4	3.8	-	-	-	8.3	3.4	9.7
"Low"		19.3	36.4	22.7	28.0	44.4	26.5	12.8	50.0	45.5	-	33.3	21.0	60.5
"Acceptable"		21.1	29.1	31.8	40.0	27.8	26.5	30.8	41.7	45.5	83.3	41.7	37.0	26.6
"High"		57.0	34.5	40.9	20.0	22.2	43.6	52.6	8.3	9.1	16.7	16.7	38.7	3.2
Mean Corpuscular Hemoglobin Concentration	No.	114	55	22	25	18	234	78	12	11	6	12	119	124
Percent	Mean	31.8	31.3	32.2	31.5	30.7	31.6	31.6	31.4	32.1	31.4	32.0	31.7	31.4
		Percent Distribution												
<28.0		2.6	3.6	4.5	-	16.7	3.8	2.6	-	-	-	-	1.7	4.0
28.0-29.9		11.4	12.7	4.5	12.0	11.1	11.1	12.8	16.7	9.1	33.3	8.3	13.4	17.7
30.0-31.9		42.1	54.5	22.7	52.0	33.3	43.6	44.9	50.0	54.5	33.3	41.7	45.4	46.8
≥32.0		43.9	29.1	68.2	36.0	38.9	41.4	39.7	33.3	36.4	33.3	50.0	39.5	31.5
Plasma Vitamin C	No.	109	28	21	17	17	192	72	10	7	7	10	106	119
mg/100 ml	Mean	1.70	1.27	1.54	1.50	1.34	1.57	1.71	1.42	1.02	0.97	1.32	1.55	1.11
		Percent Distribution												
<.10 "Deficient"		-	-	-	-	-	-	-	-	-	-	-	-	0.8
.10-.19 "Low"		-	-	-	-	-	-	-	-	-	-	-	-	1.7
.20-.39 "Acceptable"		1.8	3.6	-	-	17.6	3.1	5.6	-	-	14.3	10.0	5.7	10.1
≥.40 "High"		98.2	96.4	100.0	100.0	82.4	96.9	94.4	100.0	100.0	85.7	90.0	94.3	87.4

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APPENDIX TABLE 6 . BIOCHEMICAL FINDINGS BY SEX AND AGE, NIGERIA (continued)

		Males						Nonpregnant, Nonlactating Females						Pregnant or Lactating
		Age in Years						Age in Years						
		5-14	15-24	25-34	35-44	45+	Total	5-14	15-24	25-34	35-44	45+	Total	All Ages
Plasma Vitamin A µg/100 ml	No.	100	50	22	19	19	210	65	11	10	6	10	102	116
	Mean													
		Percent Distribution												
<10	"Deficient"	1.0	-	-	-	-	0.5	-	-	-	-	-	-	1.7
10-19	"Low"	4.0	-	-	-	-	1.9	6.2	-	-	-	-	3.9	2.6
20-49	"Acceptable"	76.0	32.0	36.4	21.1	31.6	52.4	56.9	54.5	50.0	33.3	20.0	51.0	44.0
≥50	"High"	19.0	68.0	63.6	78.9	68.4	45.2	36.9	45.5	50.0	66.7	80.0	45.1	51.7
Plasma Carotene µg/100 ml	No.	100	50	22	19	19	219	65	11	10	6	10	102	116
	Mean	247	304	280	263	238	265	278	284	286	270	294	280	284
		Percent Distribution												
<20	"Deficient"													
20-39	"Low"	-	-	-	-	-	-	-	-	-	-	-	-	-
40-90	"Acceptable"	3.0	-	-	5.3	5.3	2.4	-	-	-	-	-	-	6.0
≥100	"High"	97.0	100.0	100.0	94.7	94.7	97.6	100.0	100.0	100.0	100.0	100.0	100.0	94.0
Plasma Cholesterol mg/100 ml	No.	106	54	23	22	19	224	73	11	10	6	12	112	123
	Mean	132	137	139	160	146	138	144	162	154	153	175	150	182
		Percent Distribution												
50-99		20.8	7.4	8.7	9.1	5.3	13.8	16.4	9.1	10.0	16.7	-	13.4	1.6
100-149		46.2	59.3	52.2	27.3	63.2	49.6	37.0	18.2	30.0	16.7	25.0	32.1	17.1
150-199		30.2	33.3	37.1	40.9	21.1	32.1	37.0	63.6	50.0	66.7	50.0	43.8	48.8
≥200		2.8	-	-	22.7	10.5	4.5	9.6	9.1	10.0	-	25.0	10.7	32.5
Iodine Excretion µg/gm Creatinine	No.	39	13	4	4	5	65	30	4	2	2	4	42	41
	Median	106	84	70	137	59	94	98	109	146	78	300	106	108
		Percent Distribution												
<50 1/		7.7	23.1	25.0	-	20.0	12.3	10.0	25.0	-	-	-	9.5	2.4
50-99		38.5	53.8	50.0	50.0	60.0	44.6	40.0	25.0	-	100.0	-	35.7	46.3
≥100		53.8	23.1	25.0	50.0	20.0	43.1	50.0	50.0	100.0	-	100.0	54.8	51.2

1/ An excretion of iodine below 50 µg/gm of creatinine is considered indicative of an inadequate iodine intake.

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APPENDIX TABLE 6. BIOCHEMICAL FINDINGS BY SEX AND AGE, NIGERIA (continued)

		Males						Nonpregnant, Nonlactating Females						Pregnant or Lactating
		Age in Years						Age in Years						
		5-14	15-24	25-34	35-44	45+	Total	5-14	15-24	25-34	35-44	45+	Total	All Ages
Thiamine Excretion	No.	113	55	22	21	21	232	74	10	8	9	12	113	110
µg/gm creatinine	Median	286	102	76	41	71	140	230	90	72	158	112	186	103
		Percent Distribution												
"Deficient"		1.8	-	18.2	19.0	14.3	5.6	6.8	-	12.5	-	-	5.3	5.5
"Low"		23.9	25.5	27.3	52.4	28.6	27.6	23.0	30.0	37.5	22.2	16.7	23.9	21.8
"Acceptable"		31.9	43.6	27.3	14.3	33.3	32.8	50.0	30.0	37.5	22.2	41.7	44.2	31.8
"High"		42.5	30.9	27.3	14.3	23.8	34.1	20.3	40.0	12.5	55.6	41.7	26.5	40.9
Riboflavin Excretion	No.	119	55	23	23	22	242	73	11	9	9	12	114	115
µg/gm creatinine	Median	61	35	32	36	38	46	60	46	55	49	26	54	48
		Percent Distribution												
"Deficient"		64.7	29.1	34.8	39.0	18.2	47.1	67.1	18.2	-	22.2	50.0	51.8	20.9
"Low"		28.6	61.8	60.9	34.8	63.6	43.0	28.8	72.7	77.8	55.6	33.3	39.5	59.1
"Acceptable"		5.9	9.1	-	26.1	18.2	9.1	4.1	9.1	22.2	11.1	16.7	7.9	17.4
"High"		0.8	-	4.3	-	-	0.8	-	-	-	11.1	-	0.9	2.6
N'-Methyl-Nicotinamide	No.	114	53	19	22	19	227	71	8	8	7	11	105	111
mg/gm creatinine	Median	3.3	2.3	1.2	1.6	2.5	2.5	3.4	3.5	2.8	2.4	2.5	3.0	3.4
		Percent Distribution												
<0.5 "Deficient"		0.9	-	-	4.5	10.5	1.8	2.8	-	-	-	-	1.9	0.9
0.5-1.59 "Low"		5.3	24.5	63.2	36.4	21.1	18.9	9.9	37.5	12.5	14.3	18.2	13.3	13.5
1.6-4.29 "Acceptable"		61.4	73.6	26.3	59.1	42.1	59.5	52.1	37.5	62.5	57.1	72.7	54.3	47.7
≥4.3 "High"		32.5	1.9	10.5	-	26.3	19.8	35.2	25.0	25.0	28.6	9.1	30.5	37.8

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APPENDIX TABLE 7. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION, NIGERIA

Males, 5-14 years

	Region						
	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Total Plasma Protein No.	35	20	8	16	12	16	107
gm/100 ml Mean	7.37	7.90	7.50	7.41	7.31	7.88	7.55
	Percent Distribution						
<6.0 "Deficient"	-	-	-	-	-	-	-
6.0-6.4"Low"	2.9	-	-	-	8.3	-	1.9
6.5-6.9"Acceptable"	17.1	-	12.5	18.8	8.3	-	10.3
≥7.0 "High"	80.0	100.0	87.5	81.2	83.3	100.0	87.9
Plasma Albumin No.	35	20	8	16	12	16	107
gm/100 ml Mean	3.05	3.87	3.37	3.63	2.95	3.65	3.39
	Percent Distribution						
<2.8 "Deficient"	22.9	-	-	-	50.0	-	13.1
2.8-3.4"Low"	62.9	5.0	62.5	12.5	33.3	25.0	35.5
3.5-4.2"Acceptable"	14.3	90.0	37.5	87.5	16.7	75.0	50.5
≥4.3 "High"	-	5.0	-	-	-	-	0.9
Plasma Globulin No.	35	20	8	16	12	16	107
gm/100 ml Mean	4.37	4.04	4.13	3.78	4.37	4.28	4.19
	Percent Distribution						
1.0-1.9"Deficient"	-	-	-	-	-	-	-
2.0-2.9"Low"	-	-	-	-	-	6.2	0.9
3.0-3.5"Acceptable"	14.3	15.0	12.5	37.5	8.3	6.2	15.9
≥ 3.5 "High"	85.7	85.0	87.5	62.5	91.7	87.5	83.2
A/G ratio No.	35	20	8	16	12	16	107
Mean	0.71	0.98	0.83	0.98	0.70	0.89	0.83
	Percent Distribution						
<0.5	2.9	-	-	-	-	-	0.9
0.5-0.9	91.4	55.0	100.0	50.0	91.7	81.2	77.6
1.0-1.4	5.7	45.0	-	50.0	8.3	18.8	21.5
1.5-1.9	-	-	-	-	-	-	-
≥2.0	-	-	-	-	-	-	-

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(Continued) APPENDIX TABLE 7. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION, NIGERIA

	Males, 5-14 years						
	Region						
	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Hemoglobin No.	39	20	8	18	12	16	114
gm/100 ml Mean	11.3	12.5	13.2	12.3	10.4	11.7	11.8
			Percent Distribution				
<10.0 "Deficient"	23.1	-	-	-	25.0	6.2	11.4
10.0-10.9 "Low"	23.1	4.8	-	-	41.7	18.8	15.8
11.0-11.9 "Acceptable	23.1	33.3	12.5	38.9	33.3	37.5	29.8
≥12.0 "High"	30.8	62.0	87.5	61.1	-	37.5	43.0
Hematocrit No.	39	21	8	18	12	16	114
Percent Mean	35.7	39.4	40.4	38.4	32.5	37.1	37.0
			Percent Distribution				
<30.0 "Deficient"	5.1	-	-	-	8.3	-	2.6
30.0-33.9 "Low"	25.6	-	-	5.6	75.0	12.5	19.3
34.0-36.9 "Acceptable"	30.8	9.5	-	16.7	16.7	31.2	21.1
≥37.0 "High"	38.5	90.5	100.0	77.8	-	56.2	57.0
Mean Corpuscular Hemoglobin Concentration No.	39	21	8	18	12	16	114
Percent Mean	31.6	31.7	32.7	32.1	31.9	31.6	31.8
			Percent Distribution				
<28.0	2.6	-	-	5.6	-	6.2	2.6
28.0-29.9	15.4	9.5	-	-	16.7	18.8	11.4
30.0-31.9	43.6	57.1	37.5	50.0	25.0	25.0	42.1
≥32.0	38.5	33.3	62.5	44.4	58.3	50.0	43.9
Plasma Vitamin C No.	38	20	8	16	11	16	109
mg/100 ml Mean	1.98	1.17	1.93	1.61	1.94	1.51	1.70
			Percent Distribution				
<.10 "Deficient"	-	-	-	-	-	-	-
.10-.19 "Low"	-	-	-	-	-	-	-
.20-.39 "Acceptable"	-	-	-	6.2	-	6.2	1.8
≥.40 "High"	100.0	100.0	100.0	93.8	100.0	93.8	98.2

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(Continued) APPENDIX TABLE 7. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION, NIGERIA

	Males, 5-14 years						
	Region						
	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Plasma Vitamin A No.	34	20	6	16	9	15	100
µg/100 ml Mean	34.1	43.4	40.7	43.6	30.3	44.6	39.1
			Percent Distribution				
<10 "Deficient"	2.9	-	-	-	-	-	1.0
10-19"Low"	8.8	-	-	-	11.1	-	4.0
20-49"Acceptable	79.4	70.0	66.7	75.0	77.8	80.0	76.0
≥50 "High"	8.8	30.0	33.3	25.0	11.1	20.0	19.0
Plasma Carotene No.	34	20	6	16	9	15	100
µg/100 ml Mean	222	294	241	274	178	254	247
			Percent Distribution				
<20 "Deficient							
20-39"Low"	-	-	-	-	-	-	-
40-90"Acceptable"	2.9	-	-	-	22.2	-	3.0
≥ 100 "High	97.1	100.0	100.0	100.0	77.8	100.0	97.0
Plasma Cholesterol No.	35	20	8	16	12	15	106
mg/100 ml Mean	109	148	152	169	110	133	132
			Percent Distribution				
50- 99	34.3	-	-	-	58.3	20.0	20.8
100-149	60.0	60.0	62.5	12.5	16.7	46.7	46.2
150-199	5.7	30.0	37.5	81.2	25.0	33.3	30.2
≥200	-	10.0	-	6.2	-	-	2.8
Iodine Excretion No.	15	7	4	6	1	6	39
µg/gm Median	84	120	179	72	111	124	106
Creatinine			Percent Distribution				
<50 1/	20.0	-	-	-	-	-	7.7
50- 99	40.0	42.9	-	66.7	-	33.3	38.5
≥100	40.0	57.1	100.0	33.3	100.0	66.7	53.8

1/ An excretion of iodine below 50 µg/gm of creatinine is considered indicative of an inadequate iodine intake.

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(Continued) APPENDIX TABLE 7. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION, NIGERIA

	Males, 5-14 years						
	Region						
	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Thiamine Excretion No.	28	17	7	14	11	36	113
µg/gm Creatinine Median	468	219	250	144	275	304	286
			Percent Distribution				
"Deficient"	-	-	-	7.1	-	2.8	1.8
"Low"	10.7	47.1	14.3	50.0	36.4	11.1	23.9
"Acceptable"	28.6	11.8	42.9	35.7	18.2	44.4	31.9
"High"	60.7	41.2	42.9	7.1	45.5	41.7	42.5
Riboflavin Excretion No.	31	20	8	14	11	35	119
µg/gm Creatinine Median	80	50	52	36	51	71	61
			Percent Distribution				
"Deficient"	54.8	75.0	62.5	85.7	72.7	57.1	64.7
"Low"	29.0	25.0	37.5	-	27.3	40.0	28.6
"Acceptable"	12.9	-	-	14.3	-	2.9	5.9
"High"	3.2	-	-	-	-	-	0.8
N'-Methyl-nicotinamide No.	29	20	8	14	11	32	114
mg/gm Creatinine Median	4.1	3.5	2.6	2.6	2.6	4.0	3.3
			Percent Distribution				
<0.5 "Deficient"	-	-	-	-	-	3.1	0.9
0.5-1.59 "Low"	3.4	5.0	12.5	7.1	9.1	3.1	5.3
1.6-4.29 "Acceptable"	51.7	60.0	87.5	78.6	81.8	50.0	61.4
≥4.3 "High"	44.8	35.0	-	14.3	9.1	43.8	32.5

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APPENDIX TABLE 8. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION, NIGERIA

	Females 5-14 years						
	Region						
	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Total Plasma Protein No.	9	6	3	22	30	6	76
gm/100 ml Mean	7.38	8.10	7.43	7.29	7.77	7.72	7.59
			Percent Distribution				
<6.0 "Deficient"	-	-	-	-	-	-	-
6.0-6.4 "Low"	-	-	-	-	-	-	-
6.5-6.9 "Acceptable"	-	-	-	18.2	3.3	16.7	7.9
≥7.0 "High"	100.0	100.0	100.0	81.8	96.7	83.3	92.1
Plasma Albumin No.	9	6	3	21	30	6	75
gm/100 ml Mean	2.86	3.46	3.44	3.53	3.56	3.44	3.44
			Percent Distribution				
<2.8 "Deficient"	33.3	-	-	4.8	6.7	-	8.0
2.8-3.4 "Low"	55.6	66.7	33.3	28.6	43.3	83.3	45.3
3.5-4.2 "Acceptable"	11.1	33.3	66.7	66.7	36.7	16.7	41.3
≥ 4.3 "High"	-	-	-	-	13.3	-	5.3
Plasma Globulin No.	9	6	3	21	30	6	75
gm/100 ml Mean	4.56	4.66	4.04	3.80	4.16	4.30	4.15
			Percent Distribution				
1.0-1.9 "Deficient"	-	-	-	-	-	-	-
2.0-2.9 "Low"	-	-	-	-	6.7	-	2.7
3.0-3.5 "Acceptable"	-	-	-	42.9	16.7	33.3	21.3
≥3.5 "High"	100.0	100.0	100.0	57.1	76.7	66.7	76.0
A/G ratio No.	9	6	3	21	30	6	75
Mean	0.63	0.78	0.88	0.96	0.90	0.83	0.87
			Percent Distribution				
<0.5	22.2	-	-	4.8	3.3	-	5.3
0.5-0.9	66.7	83.3	66.7	52.4	63.3	64.0	
1.0-1.4	11.1	16.7	33.3	42.9	30.0	16.7	29.3
1.5-1.9	-	-	-	-	3.3	-	1.3
≥2.0	-	-	-	-	-	-	-

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(Continued) APPENDIX TABLE 8 . BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION, NIGERIA

	Females 5-14 years						
	Region						
	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Hemoglobin No.	9	6	3	23	31	6	78
gm/100 ml Mean	11.2	11.9	12.7	11.9	11.3	11.5	11.6
			Percent Distribution				
<10.0 "Deficient"	11.1	-	-	-	19.4	-	9.0
10.0-10.9 "Low"	33.3	33.3	-	13.0	22.6	33.3	21.8
11.0-11.9 "Acceptable"	33.3	-	33.3	47.9	19.4	33.3	29.5
≥12.0 "High"	22.2	66.7	66.7	39.1	38.7	33.3	39.7
Hematocrit No.	9	6	3	23	31	6	78
Percent Mean	35.4	36.2	39.3	37.6	35.9	36.3	36.5
			Percent Distribution				
<30.0 "Deficient"	-	-	-	-	9.7	-	3.8
30.0-33.9 "Low"	22.2	16.7	-	4.3	19.4	-	12.8
34.0-36.9 "Acceptable"	44.4	33.3	33.3	34.8	16.1	66.7	30.8
≥37.0 "High"	33.3	50.0	66.7	60.9	54.8	33.3	52.6
Mean Corpuscular Hemoglobin Concentration No.	9	6	3	23	31	6	78
Percent Mean	31.7	32.8	32.1	31.1	31.7	31.8	31.6
			Percent Distribution				
<28.0	-	-	-	8.7	-	-	2.6
28.0-29.9	11.1	-	-	17.4	13.0	16.7	12.8
30.0-31.9	44.4	33.3	33.3	39.1	51.6	50.0	44.9
≥32.0	44.4	66.7	66.7	34.8	35.5	33.3	39.7
Plasma Vitamin C No.	9	6	3	19	29	6	72
mg/100 ml Mean	2.03	1.83	1.22	1.40	1.84	1.46	1.71
			Percent Distribution				
<.10 "Deficient"	-	-	-	-	-	-	-
.10-.19 "Low"	-	-	-	-	-	-	-
.20-.39 "Acceptable"	-	-	-	15.8	-	16.7	5.6
≥.40 "High"	100.0	100.0	100.0	84.2	100.0	83.3	94.4

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(Continued) APPENDIX TABLE 8. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION, NIGERIA

	Females, 5-14 years						
	Region						
	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Plasma Vitamin A No.	8	5	2	18	27	5	65
µg/100 ml Mean	34.2	22.4	33.5	48.2	49.8	48.2	44.7
			Percent Distribution				
<10 "Deficient"	-	-	-	-	-	-	-
10-19"Low"	12.5	40.0	-	-	3.7	-	6.2
20-49"Acceptable"	87.5	60.0	100.0	61.1	40.7	60.0	56.9
≥50 "High"	-	-	-	38.9	55.6	40.0	36.9
Plasma Carotene No.	8	5	2	18	27	5	65
µg/100 ml Mean	227	186	184	306	294	302	278
			Percent Distribution				
<20 "Deficient"							
20-39"Low"	-	-	-	-	-	-	-
40-90"Acceptable"	-	-	-	-	-	-	-
≥ 100 "High"	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Plasma Cholesterol No.	8	6	3	20	30	6	73
mg/100 ml Mean	106	141	154	180	130	141	144
			Percent Distribution				
50- 99	37.5	-	-	-	26.7	16.7	16.4
100-149	62.5	50.0	66.7	10.0	43.3	33.3	37.0
150-199	-	50.0	-	75.0	23.3	33.3	37.0
≥200	-	-	33.3	15.0	6.7	16.7	9.6
Iodine Excretion No.	2	1	1	13	9	4	30
µg/gm Creatinine Median	115	107	56	115	64	148	98
			Percent Distribution				
<50 1/	-	-	-	7.7	22.2	-	10.0
50-99	-	-	100.0	30.8	55.6	50.0	40.0
≥ 100	100.0	100.0	-	61.5	22.2	50.0	50.0

1/ An excretion of iodine below 50 µg/gm of creatinine is considered indicative of an inadequate iodine intake.

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(Continued) APPENDIX TABLE 8. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION, NIGERIA

		Females, 5-14 years						
		Region						
		Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Thiamine Excretion	No.	5	5	3	25	25	11	74
µg/gm Creatinine	Median	320	784	163	214	216	264	230
				Percent Distribution				
"Deficient"		-	-	-	8.0	12.0	-	6.8
"Low"		-	-	66.7	28.0	20.0	27.3	23.0
"Acceptable"		80.0	-	33.3	48.0	60.0	45.5	50.0
"High"		20.0	100.0	-	16.0	8.0	27.3	20.3
Riboflavin Excretion	No.	5	5	3	25	25	10	73
µg/gm Creatinine	Median	79	91	80	66	47	82	60
				Percent Distribution				
"Deficient"		60.0	40.0	33.3	68.0	80.0	60.0	67.1
"Low"		20.0	60.0	66.7	28.0	16.0	40.0	28.8
"Acceptable"		20.0	-	-	4.0	4.0	-	4.1
"High"		-	-	-	-	-	-	-
N'-Methyl-nicotinamide	No.	3	5	3	24	25	11	71
mg/gm Creatinine	Median	1.8	4.0	2.3	4.4	2.6	4.3	3.4
				Percent Distribution				
<0.5	"Deficient"	-	-	-	4.2	-	9.1	2.8
0.5-1.5	"Low"	33.3	-	-	4.2	20.0	-	9.9
1.6-4.2	"Acceptable"	66.7	60.0	66.7	37.5	68.0	36.4	52.1
≥4.3	"High"	-	40.0	33.3	54.2	12.0	54.5	35.2

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APPENDIX TABLE 9. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION
NIGERIA

Males, 15+ years

Region	Derived Savannah	Savannah	Urban Federal Plateau	District	Rain Forest	Coastal	Total
Total Plasma Protein No.	49	10	5	14	20	22	120
gm/100 ml Mean	7.70	7.61	7.54	6.97	7.46	7.81	7.58
			Percent Distribution				
<6.0 "Deficient"	-	10.0	-	-	-	-	0.8
6.0- 6.4"Low"	-	-	-	14.3	-	-	1.7
6.5- 6.9"Acceptable"	2.0	-	20.0	35.7	10.0	-	7.5
≥7.0 "High"	98.0	90.0	80.0	50.0	90.0	100.0	90.0
Plasma Albumin No.	49	10	5	11	17	23	115
gm/100 ml Mean	3.45	4.34	3.46	3.09	3.76	3.52	3.55
			Percent Distribution				
<2.8 "Deficient"	12.2	-	20.0	9.1	5.9	-	7.8
2.8- 3.4"Low"	30.6	-	-	90.9	29.4	47.8	35.7
3.5- 4.2"Acceptable"	55.1	40.0	80.0	-	58.8	47.8	48.7
≥4.3 "High"	2.0	60.0	-	-	5.9	4.3	7.8
Plasma Globulin No.	49	10	5	11	17	22	114
gm/100 ml Mean	4.23	3.28	4.02	3.76	3.76	4.32	4.04
			Percent Distribution				
1.0- 1.9"Deficient"	-	10.0	-	-	-	-	0.9
2.0- 2.9"Low"	2.0	-	-	-	11.8	-	2.6
3.0- 3.5"Acceptable"	12.2	50.0	20.0	36.4	23.5	13.6	20.2
≥3.5 "High"	85.7	40.0	80.0	63.6	64.7	86.4	76.3
A/G Ratio No	49	10	5	11	17	22	114
Mean	0.86	1.46	0.84	0.85	1.05	0.85	0.94
			Percent Distribution				
<0.5	6.1	-	-	-	-	-	2.6
0.5- 0.9	65.3	10.0	80.0	90.9	47.1	72.7	62.3
1.0- 1.4	28.6	80.0	20.0	9.1	47.1	27.3	33.3
1.5- 1.9	-	-	-	-	5.9	-	0.9
≥2.0	-	10.0	-	-	-		

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(Continued) APPENDIX TABLE 9. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION
NIGERIA

Region		Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
		Males 15+ years						
Hemoglobin gm/100 ml	No.	52	10	5	14	19	23	123
	Mean	13.2	13.6	14.4	13.5	13.8	13.3	13.4
				Percent Distribution				
<12.0	"Deficient"	17.3	-	-	21.4	21.1	8.7	14.6
12.0-13.9	"Low"	50.0	60.0	40.0	35.7	36.8	78.3	52.0
14.0-14.9	"Acceptable"	28.8	20.0	20.0	35.7	21.1	8.7	23.6
≥15.0	"High	3.8	20.0	40.0	7.1	21.1	4.3	9.8
Hematocrit percent	No.	51	8	5	14	19	23	120
	Mean	42.6	44.9	45.4	42.8	42.4	41.5	42.6
				Percent Distribution				
<36.0	"Deficient"	2.0	-	-	7.1	10.5	4.3	4.2
36.0-41.0	"Low"	41.2	-	-	14.3	31.6	47.8	33.3
42.0-44.0	"Acceptable"	29.4	37.5	20.0	50.0	21.1	34.8	31.7
≥45.0	"High"	27.5	62.5	80.0	28.6	36.8	13.0	30.8
Mean Corpuscular Hemoglobin Concentration Percent	No.	51	8	5	14	19	23	120
	Mean	31.1	30.0	31.4	31.6	32.3	31.6	31.4
				Percent Distribution				
<28.0		7.8	25.0	-	-	-	-	5.0
28.0-29.9		11.8	12.5	-	-	5.3	21.7	10.8
30.0-31.9		49.0	37.5	80.0	64.3	26.3	34.8	45.0
≥32.0		31.4	25.0	20.0	35.7	68.4	43.5	39.2
Plasma Vitamin C mg/100 ml	No.	23	10	4	1	21	24	83
	Mean	1.82	0.62	0.64	1.54	1.52	1.34	1.40
				Percent Distribution				
<.10	"Deficient"	-	-	-	-	-	-	-
.10-.19	"Low"	-	-	-	-	-	-	-
.20-.39	"Acceptable"	-	10.0	25.0	-	-	8.3	4.8
≥.40	"High"	100.0	90.0	75.0	100.0	100.0	91.7	95.2

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(Continued) APPENDIX TABLE 9. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION
NIGERIA

Males, 15+ years

Region	Derived Savannah	Savannah	Urban Federal Plateau	District	Rain Forest	Coastal	Total
Plasma Vitamin A No.	44	10	4	11	19	22	110
µg/100 ml Mean	59.8	56.0	48.8	76.7	58.1	56.8	59.8
			Percent Distribution				
<10 "Deficient"	-	-	-	-	-	-	-
10-19 "Low"	-	-	-	-	-	-	-
20-49 "Acceptable"	27.3	20.0	50.0	9.1	36.9	45.5	30.9
≥50 "High"	72.7	80.0	50.0	90.9	63.2	54.5	69.1
Plasma Carotene No.	44	10	4	11	19	22	110
µg/100 ml. Mean	265	428	152	293	269	274	281
			Percent Distribution				
<20 "Deficient"							
20-39 "Low"	-	-	-	-	-	-	-
40-90 "Acceptable"	2.3	-	25.0	-	-	-	1.8
≥100 "High"	97.7	100.0	75.0	100.0	100.0	100.0	98.2
Plasma Cholesterol No.	48	10	5	13	20	22	118
mg/100 ml. Mean	134	142	142	150	148	157	143
			Percent Distribution				
50-99	10.4	-	-	7.7	5.0	9.1	7.6
100-149	62.5	60.0	80.0	30.8	45.0	40.9	52.5
150-199	27.1	40.0	-	61.5	45.0	27.3	33.9
≥200	-	-	20.0	-	5.0	22.7	5.9
Iodine Excretion No.	6	8	2	4	4	2	26
µg/gm Creatinine Median	87	74	212	55	87	302	82
			Percent Distribution				
<50 1/	-	37.5	-	25.0	25.0	-	19.2
50-99	83.3	37.5	50.0	75.0	25.0	50.0	53.8
≥100	16.7	25.0	50.0	-	50.0	50.0	26.9

1/ An excretion of iodine below 50 µg/gm creatinine is considered indicative of an inadequate iodine intake.

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(Continued) APPENDIX TABLE 9. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION
NIGERIA

Males, 15+ years

Region	Derived Savannah	Savannah	Urban Federal Plateau	District	Rain Forest	Costal	Total
Thiamine Excretion No.	49	11	5	12	18	24	119
µg/gm Creatinine Median	97	76	123	44	105	46	87
			Percent Distribution				
<27 "Deficient"	4.1	-	-	16.7	-	29.2	9.2
27-65 "Low"	28.6	27.3	20.0	50.0	33.3	29.2	31.1
66-129 "Acceptable"	36.7	54.5	40.0	16.7	33.3	25.0	33.6
≥130 "High"	30.6	18.2	40.0	16.7	33.3	16.7	26.1
Riboflavin Excretion No.	52	10	5	12	19	25	123
µg/gm Creatinine Median	34	26	35	33	37	62	36
			Percent Distribution				
<27 "Deficient"	25.0	60.0	20.0	33.3	26.3	32.0	30.1
27-79 "Low"	67.3	40.0	40.0	58.3	68.4	36.0	56.9
80-269 "Acceptable"	7.7	-	40.0	-	5.3	32.0	12.2
≥270 "High"	-	-	-	8.3	-	-	0.8
N'-Methyl-nicotinamide No.	45	10	5	12	19	22	113
mg/gm Creatinine Median	2.4	1.6	1.2	1.8	1.3	1.8	1.9
			Percent Distribution				
≤0.5 "Deficient"	2.2	-	20.0	-	-	4.5	2.7
0.5-1.59 "Low"	15.6	40.0	40.0	41.7	68.4	27.3	32.7
1.6-4.29 "Acceptable"	82.2	60.0	-	58.3	21.1	50.0	57.5
≥4.3 "High"	-	-	40.0	-	10.5	18.2	7.1

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APPENDIX TABLE 10. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION, NIGERIA

Region	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Nonlactating, Nonpregnant Females, 15+ years							
Total Plasma Protein No.	13	-	3	5	11	9	41
gm/100 ml Mean	7.87	-	7.53	6.72	7.65	7.72	7.61
			Percent Distribution				
<6.0 "Deficient"	-	-	-	-	-	-	-
6.0-6.4 "Low"	-	-	-	20.0	-	-	2.4
6.5-6.9 "Acceptable"	-	-	-	80.0	9.1	-	12.2
≥7.0 "High"	100.0	-	100.0	-	90.9	100.0	85.4
Plasma Albumin No.	13	-	3	5	11	9	41
gm/100 ml Mean	3.34	-	3.61	2.88	3.56	3.42	3.38
			Percent Distribution				
<2.8 "Deficient"	7.7	-	-	-	-	22.2	7.3
2.8-3.4 "Low"	46.2	-	33.3	100.0	36.4	33.3	46.3
3.5-4.2 "Acceptable"	46.2	-	66.7	-	54.5	33.3	41.5
≥4.3 "High"	-	-	-	-	9.1	11.1	4.9
Plasma Globulin No.	13	-	3	5	11	9	41
gm/100 ml Mean	4.51	-	3.91	3.88	4.12	4.33	4.25
			Percent Distribution				
1.0-1.9 "Deficient"	-	-	-	-	-	-	-
2.0-2.9 "Low"	-	-	-	-	-	-	-
3.0-3.5 "Acceptable"	7.7	-	33.3	20.0	27.3	22.2	19.5
≥3.5 "High"	92.3	-	66.7	80.0	72.7	77.8	80.5
A/G ratio No.	13	-	3	5	11	9	41
Mean	0.77	-	0.94	0.74	0.86	0.86	0.82
			Percent Distribution				
<0.5	7.7	-	-	-	-	-	2.4
0.5-0.9	84.6	-	33.3	100.0	63.6	77.8	75.6
1.0-1.4	7.7	-	66.7	-	36.4	22.2	22.0
1.5-1.9	-	-	-	-	-	-	-
≥2.0	-	-	-	-	-	-	-

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(Continued) APPENDIX TABLE 10. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION, NIGERIA

Nonlactating, Nonpregnant Females, 15+ years

Region	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Hemoglobin No.	13	-	3	6	10	9	41
gm/100 ml Mean	12.2	-	11.9	11.6	12.1	12.2	12.1
			Percent Distribution				
<10.0 "Deficient"	23.1	-	-	-	10.0	-	9.8
10.0-10.9 "Low"	-	-	-	16.7	20.0	22.2	12.2
11.0-14.4 "Acceptable"	61.5	-	100.0	-	50.0	66.7	65.9
≥14.5 "High"	15.4	-	-	83.3	20.0	11.1	12.2
Hematocrit No.	13	-	3	6	10	9	41
percent Mean	38.5	-	39.0	36.7	38.2	37.4	38.0
			Percent Distribution				
<30 "Deficient"	7.7	-	-	-	-	-	2.4
30-37 "Low"	15.4	-	33.3	50.0	50.0	44.4	36.6
38-42 "Acceptable"	53.8	-	66.7	50.0	30.0	55.6	48.8
≥43 "High"	23.1	-	-	-	20.0	-	12.2
Mean Corpuscular No.	13	-	3	6	10	9	41
Hemoglobin Concentration	31.7	-	30.8	31.6	31.6	32.6	31.8
Percent Mean			Percent Distribution				
<28.0	-	-	-	-	-	-	-
28.0-29.9	15.4	-	66.7	-	10.0	11.1	14.6
30.0-31.9	38.5	-	-	83.3	60.0	33.3	46.3
≥32.0	46.2	-	33.3	16.7	30.0	55.6	39.0
Plasma Vitamin C No.	12	-	2	-	11	9	34
mg/100 ml Mean	1.50	-	0.74	-	1.18	1.00	1.22
			Percent Distribution				
<.10 "Deficient"	-	-	-	-	-	-	-
.10-.19 "Low"	-	-	-	-	-	-	-
.20-.39 "Acceptable"	-	-	-	-	18.2	-	5.9
≥.40 "High"	100.0	-	100.0	-	81.8	100.0	94.1

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(Continued) APPENDIX TABLE 10 . BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION, NIGERIA

Nonlactating, Nonpregnant Females, 15+ years

Region	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Plasma Vitamin A No.	12	-	2	5	9	9	37
µg/100 ml Mean	52.7	-	33.5	68.8	57.1	57.4	56.1
			Percent Distribution				
<10 "Deficient"	-	-	-	-	-	-	-
10-19 "Low"	-	-	-	-	-	-	-
20-49 "Acceptable"	41.7	-	100.0	40.0	33.3	33.3	40.5
≥50 "High"	58.3	-	-	60.0	66.7	66.7	59.5
Plasma Carotene No.	12	-	2	5	9	9	37
µg/100 ml Mean	240	-	280	316	260	353	285
			Percent Distribution				
<20 "Deficient"							
20-39 "Low"	-	-	-	-	-	-	-
40-90 "Acceptable"	-	-	-	-	-	-	-
≥100 "High"	100.0	-	100.0	100.0	100.0	100.0	100.0
Plasma Cholesterol No.	12	-	3	5	11	8	39
mg/100 ml Mean	151	-	188	156	146	196	162
			Percent Distribution				
50- 99	8.3	-	-	-	18.2	-	7.7
100-149	33.3	-	-	40.0	27.3	-	23.1
150-199	41.7	-	66.7	60.0	54.5	75.0	56.4
≥200	16.7	-	33.3	-	-	25.0	12.8
Iodine Excretion No.	3	-	-	2	5	2	12
µg/gm Creatinine Median	135	-	-	206	83	1,263	148
			Percent Distribution				
<50 1/	-	-	-	-	20.0	-	8.3
50- 99	33.3	-	-	-	40.0	-	25.0
≥100	66.7	-	-	100.0	40.0	100.0	66.7

1/ An excretion of iodine below 50 µg/gm creatinine is considered indicative of an inadequate iodine intake.

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(Continued) APPENDIX TABLE 10. BIOCHEMICAL FINDINGS BY SEX, AGE, AND REGION, NIGERIA

Nonlactating, Nonpregnant Females, 15+ years

Region	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Thiamine Excretion No.	12	-	-	5	11	11	39
µg/gm Creatinine Median	154	-	-	83	86	83	99
				Percent Distribution			
<27 "Deficient"	-	-	-	20.0	-	-	2.6
27- 65"Low"	-	-	-	20.0	36.4	45.5	25.6
66-129"Acceptable"	41.7	-	-	60.0	27.3	18.2	33.3
≥130 "High"	58.3	-	-	-	36.4	36.4	38.5
Riboflavin Excretion No.	13	-	-	5	11	12	41
µg/gm Creatinine Median	49	-	-	33	44	49	47
				Percent Distribution			
<27 "Deficient"	30.8	-	-	20.0	27.3	16.7	24.4
27-79"Low"	53.8	-	-	60.0	45.5	75.0	58.5
80-269Acceptable"	15.4	-	-	20.0	18.2	8.3	14.6
≥270 "High"	-	-	-	-	9.1	-	2.4
N'-Methylnicotinamide No.	6	-	-	5	11	12	34
mg/gm Creatinine Median	2.5	-	-	4.0	2.2	3.6	2.8
				Percent Distribution			
<0.5 "Deficient"	-	-	-	-	-	-	-
0.5-1.59"Low"	16.7	-	-	-	36.4	16.7	20.6
1.6-4.29"Acceptable"	66.7	-	-	80.0	54.5	50.0	58.8
≥4.3 "High"	16.7	-	-	20.0	9.1	33.3	20.6

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APPENDIX TABLE 11. BIOCHEMICAL FINDINGS BY AGE, MILITARY AND POLICE, NIGERIA

	15-24 Years	25-34 Years	35-44 Years	Total
Total Plasma Protein No.	55	38	8	101
gm/100 ml Mean	7.74	7.49	7.50	7.63
		Percent Distribution		
6.0 "Deficient"	-	-	-	-
6.0-6.4 "Low"	-	-	-	-
6.5-6.9 "Acceptable"	3.6	7.9	-	5.0
7.0 "High"	96.4	92.1	100.0	95.0
Plasma Albumin No.	52	36	8	96
gm/100 ml Mean	3.81	3.97	3.92	3.86
		Percent Distribution		
2.8 "Deficient"	-	-	-	-
2.8-3.4 "Low"	11.5	11.1	25.0	12.5
3.5-4.2 "Acceptable"	82.7	69.4	62.5	76.0
4.3 "High"	5.8	19.4	12.5	11.5
Plasma Globulin No.	52	36	8	96
gm/100 ml Mean	3.91	3.59	3.60	3.77
		Percent Distribution		
1.8-1.9 "Deficient"	-	-	-	-
2.0-2.9 "Low"	-	13.9	12.5	6.2
3.0-3.5 "Acceptable"	30.8	38.9	37.5	34.4
3.5 "High"	69.2	47.2	50.0	59.4
A/G ration No.	52	36	8	96
Mean	0.991	1.12	1.13	1.051
		Percent Distribution		
0.5	-	-	-	-
0.5-0.9	53.8	38.9	50.0	47.9
1.0-1.4	46.2	52.8	37.5	47.9
1.5-1.9	-	.3	12.5	4.2
2.0	-	-	-	-

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(Continued) APPENDIX TABLE 11. BIOCHEMICAL FINDINGS BY AGE, MILITARY AND POLICE NIGERIA

		15-24 Years	25-34 Years	35-44 Years	Total
Hemoglobin gm/100 ml	No	58	39	10	107
	Mean	13.9	14.5	14.7	14.2
			Percent Distribution		
12.0	"Deficient"	3.4	-	-	1.9
12.0-13.9	"Low"	50.0	35.9	30.0	43.0
14.0-14.9	"Acceptable"	32.8	41.0	50.0	37.4
15.0	"High"	13.8	23.1	20.0	17.8
Hematocrit	No	55	39	10	104
	Mean	43.8	45.0	42.5	44.3
			Percent Distribution		
36	"Deficient"	-	-	10.0	1.0
36-41	"Low"	18.2	7.7	20.0	14.4
42-44	"Acceptable"	40.0	30.8	60.0	38.5
45	"High"	41.8	61.5	10.0	46.2
Mean Corpuscular Hemoglobin Concentration	No	55	39	10	104
	Mean	31.6	32.1	34.8	32.1
			Percent Distribution		
28.0		3.6	-	-	1.9
28.0-29.9		9.1	7.7	-	7.7
30.0-31.9		34.5	33.3	30.0	33.7
32.0		52.7	59.0	70.0	56.7
Plasma Vitamin C	No	57	39	8	104
	Mean	0.892	1.50	0.94	1.125
			Percent Distribution		
.10	"Deficient"	-	-	-	-
.10-.19	"Low"	1.8	-	-	1.0
.20-.39	"Acceptable"	22.8	2.6	-	13.5
.40	"High"	75.4	97.4	100.0	85.6

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(Continued) APPENDIX TABLE 11. BIOCHEMICAL FINDINGS BY AGE, MILITARY AND POLICE NIGERIA

		15-24 Years	25-34 Years	35-44 Years	Total
Plasma Vitamin A	No	54	34	7	95
g/100 ml	Mean	53.9	68.4	73.0	60.5
			Percent Distribution		
10 "Deficient"		1.9	-	-	1.1
10-19 "Low"		3.7	2.9	-	3.2
20-49 "Acceptable"		31.5	5.9	14.3	21.1
50 "High"		63.0	91.2	85.7	74.7
Plasma Carotene	No	54	34	7	95
	Mean	325	270	249	299
			Percent Distribution		
20-39 "Low"		-	-	-	-
40-90 "Acceptable"		-	-	-	-
100 "High"		100.0	100.0	100.0	100.0
Plasma Cholesterol	No	53	37	8	98
	Mean	156	172	192	165
			Percent Distribution		
50- 99		-	-	-	-
100-149		50.9	24.3	12.5	37.8
150-199		39.6	62.2	62.5	50.0
200		9.4	13.5	25.0	12.2
Iodine excretion	No	18	13	3	34
	Mean	38	78	71	50
			Percent Distribution		
50 1/		72.2	30.8	-	50.0
50-99		22.2	46.2	100.0	38.2
100		5.6	23.1	-	11.8

1/ An excretion of iodine below 50 ug/gm creatinine is considered indicative of an inadequate iodine intake.

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(Continued) APPENDIX TABLE 11. BIOCHEMICAL FINDINGS BY AGE, MILITARY AND POLICE NIGERIA

	15-24 Years	25-34 Years	35-44 Years	Total
Thiamine excretion No.	56	35	6	97
g/gm creatinine Mean	71	44	11	53
		Percent Distribution		
27	17.9	34.3	66.7	26.8
27- 65"Low"	28.6	28.6	33.3	28.9
66-129"Acceptable"	28.6	22.9	-	24.7
130 "High"	25.0	14.3	-	19.6
Riboflavin excretion No.	57	36	8	101
g/gm creatinine Median	40	34	28	36
		Percent Distribution		
27 "Deficient"	28.1	38.9	37.5	32.8
27- 79"Low"	66.7	38.9	62.5	56.4
80-269"Acceptable"	1.8	22.2	-	8.9
270 "High"	3.5	-	-	2.0
N'-methyl-nicotinamide No	56	35	8	99
mg/gm creatinine Median	2.0	1.6	1.4	1.9
		Percent Distribution		
0.5 "Deficient"	-	2.9	-	1.0
0.5-1.59"Low"	33.9	45.7	62.5	40.4
1.6-4.29"Acceptable"	57.1	45.7	37.5	51.5
4.3 "High"	8.9	5.7	-	7.1

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APPENDIX TABLE 12. BIOCHEMICAL FINDINGS BY REGION, MILITARY AND POLICE, NIGERIA

	Derived Savannah	Savannah	Urban Federal District	Rain Forest	Total
Total Plasma Protein No.	16	27	43	15	101
gm/100 ml Mean	7.34	7.69	7.77	7.42	7.63
			Percent Distribution		
<6.0 "Deficient"	-	-	-	-	-
6.0-6.4 "Low"	-	-	-	-	-
6.5-6.9 "Acceptable"	12.5	3.7	2.3	6.7	4.9
≥7.0 "High"	87.5	96.3	97.7	93.3	95.0
Plasma Albumin No.	14	27	42	13	96
gm/100 ml Mean	3.47	3.86	3.91	4.31	3.86
			Percent Distribution		
<2.8 "Deficient"	-	-	-	-	-
2.8-3.4 "Low"	42.9	14.8	4.8	-	12.5
3.5-4.2 "Acceptable"	57.1	77.8	90.5	46.2	76.0
≥4.3 "High"	-	7.4	4.8	53.8	11.4
Plasma Globulin No.	14	27	42	13	96
gm/100 ml Mean	3.91	3.87	3.88	3.16	3.77
			Percent Distribution		
1.0-1.9 "Deficient"	-	-	-	-	-
2.0-2.9 "Low"	-	-	2.4	38.5	6.3
3.0-3.5 "Acceptable"	35.7	22.2	40.5	38.5	34.4
≥3.5 "High"	64.3	77.8	57.1	23.1	59.4
A/G ratio No.	14	27	42	13	96
Mean	0.91	1.01	1.01	1.41	1.05
			Percent Distribution		
<0.5	-	-	-	-	-
0.5-0.9	71.4	48.1	54.8	-	47.9
1.0-1.4	28.6	51.9	42.9	76.9	47.9
1.5-1.9	-	-	2.4	23.1	4.2
>2.0	-	-	-	-	-

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(Continued) APPENDIX TABLE 12. BIOCHEMICAL FINDINGS BY REGION, MILITARY AND POLICE NIGERIA

	Derived Savannah	Savannah	Urban Federal District	Rain Forest	Total
Hemoglobin No.	18	28	44	17	107
gm/100 ml Mean	249	377	594	237	1,457
			Percent Distribution		
<12.0 "Deficient"	-	-	4.5	-	1.9
12.0-13.9 "Low"	44.4	50.0	50.0	11.8	43.0
14.0-14.9 "Acceptable"	27.8	35.7	27.3	76.5	37.4
≥15.0 "High"	27.8	14.3	18.2	11.8	17.8
Hematocrit No.	18	28	41	17	104
Percent Mean	45.2	44.4	43.6	44.7	44.3
			Percent Distribution		
<36 "Deficient"	-	-	2.4	-	1.0
36-41 "Low"	5.6	14.3	19.5	11.8	14.4
42-44 "Acceptable"	33.3	42.9	39.0	35.3	38.5
≥45 "High"	61.1	42.9	39.0	52.9	46.1
Mean Corpuscular No.	18	28	41	17	104
Hemoglobin Concentration Mean percent	32.0	31.5	31.5	32.6	32.2
			Percent Distribution		
<28.0	5.6	3.6	-	-	1.9
28.0-29.9	11.1	10.7	7.3	-	7.7
30.0-31.9	27.8	46.4	31.7	23.5	33.7
≥32.0	55.6	39.3	61.0	76.5	56.7
Plasma Vitamin C No.	18	27	43	16	104
mg/100 ml Mean	1.61	0.65	1.05	1.59	1.13
			Percent Distribution		
<.10 "Deficient"	-	-	-	-	-
.10-.19 "Low"	-	3.7	-	-	1.0
.20-.39 "Acceptable"	-	48.1	2.3	-	13.5
≥.40 "High"	100.0	48.1	97.7	100.0	85.6

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(Continued) APPENDIX TABLE 12. BIOCHEMICAL FINDINGS BY REGION, MILITARY AND POLICE NIGERIA

	Derived Savannah	Urban Federal Savannah	District	Rain Forest	Total
Plasma Vitamin A No.	9	26	43	17	95
µg/100 ml Mean	69.1	42.2	67.5	65.9	60.5
			Percent Distribution		
<10 "Deficient"	-	3.8	-	-	1.1
10-19"Low"	-	11.5	-	-	3.2
20-49"Acceptable"	-	50.0	9.3	17.6	21.1
≥50 "High"	100.0	34.6	90.7	82.4	74.7
Plasma Carotene No	9	26	43	17	95
µg/100 ml Mean	237	338	315	234	299
			Percent Distribution		
20-39"Low"	-	-	-	-	-
40-90"Acceptable"	-	-	-	-	-
≥100"High"	100.0	100.0	100.0	100.0	100.0
Plasma Cholesterol No.	16	27	43	12	98
mg/100 ml Mean	168	154	174	155	165
			Percent Distribution		
50- 99	-	-	-	-	-
100-149	31.2	48.1	34.9	33.3	37.8
150-199	62.5	44.4	46.5	58.3	50.0
≥200	6.2	7.4	18.6	8.3	12.3
Iodine Excretion No.	2	12	15	5	34
µg/gm creatinine Median	72	68	41	78	50
			Percent Distribution		
<50 1/	50.0	41.7	73.3	-	50.0
50-99	50.0	33.3	20.0	100.0	38.2
≥100	-	25.0	6.7	-	11.8

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(Continued) APPENDIX TABLE 12. BIOCHEMICAL FINDINGS BY REGION, MILITARY AND POLICE NIGERIA

	Derived Savannah	Savannah	Urban Federal District	Rain Forest	Total
Thiamine Excretion No.	14	29	38	16	97
µg/gm creatinine Median	54	100	43	32	53
			Percent Distribution		
<27 "Deficient"	7.1	13.8	36.8	43.8	26.8
27- 65"Low"	50.0	13.8	31.6	31.2	28.9
66-129"Acceptable"	28.6	41.4	21.1	-	24.7
≥130 "High"	14.3	31.0	10.5	25.0	19.6
Riboflavin Excretion No.	16	29	40	16	101
µg/gm creatinine Median	44	43	26	42	36
			Percent Distribution		
<27 "Deficient"	18.8	20.7	52.5	18.8	32.7
27- 79"Low"	56.2	75.9	40.0	62.5	56.4
80-269"Acceptable"	25.0	-	7.5	12.5	8.9
≥270 "High"	-	3.4	-	6.2	2.0
N'Mathyl-nicotinamide No.	16	28	40	15	99
mg/gm creatinine Median	1.6	2.6	1.4	2.0	1.9
			Percent Distribution		
<0.5 "Deficient"	-	-	2.5	-	1.0
0.5-1.59"Low"	50.0	14.3	55.0	40.0	40.4
1.6-4.29"Acceptable"	37.5	71.4	40.0	60.0	51.5
≥4.3 "High	12.5	14.3	2.5	-	7.1

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APPENDIX TABLE 13. BIOCHEMICAL FINDINGS FOR PREGNANT OR LACTATING FEMALES BY REGION, NIGERIA

	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Total Plasma Protein No.	29	-	26	17	38	14	124
gm/100 ml Mean	6.97	-	7.31	7.04	6.96	7.30	7.09
			Percent Distribution				
<5.5 "Deficient"	-	-	-	-	-	-	-
5.5-5.9 "Low"	-	-	-	-	-	-	-
6.0-6.9 "Acceptable"	51.7	-	26.9	29.4	60.5	57.1	46.8
≥7.0 "High"	48.3	-	73.1	70.6	39.5	42.9	53.2
Plasma Albumin No.	29	-	26	17	38	13	123
gm/100 ml Mean	2.54	-	3.37	2.72	3.07	3.13	2.97
			Percent Distribution				
<3.0 "Deficient"	79.3	-	19.2	76.5	60.5	53.8	57.7
3.0-3.4 "Low"	17.2	-	34.6	23.5	18.4	15.4	22.0
3.5-4.4 "Acceptable"	3.4	-	46.2	-	18.4	30.8	19.5
≥4.5 "High"	-	-	-	-	2.6	-	0.8
Plasma Globulin No.	29	-	26	17	38	13	123
gm/100 ml Mean	4.43	-	3.95	4.39	3.87	4.18	4.12
			Percent Distribution				
<1.4 "Deficient"	-	-	-	-	-	-	-
1.4-1.9 "Low"	-	-	-	-	-	-	-
2.0-2.9 "Acceptable"	-	-	3.8	-	5.3	-	2.4
≥3.0 "High	100.0	-	96.2	100.0	94.7	100.0	97.6
A/G Ration No.	29	-	26	17	38	13	123
Mean	0.59	-	0.89	0.64	0.82	0.74	0.75
			Percent Distribution				
<0.5	34.5	-	-	17.6	2.6	-	11.4
0.5-0.9	62.1	-	76.9	82.4	78.9	100.0	77.2
1.0-1.4	3.4	-	23.1	-	15.8	-	10.6
1.5-1.9	-	-	-	-	2.6	-	0.8
> 20	-	-	-	-	-	-	-

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(Continued) APPENDIX TABLE 13. BIOCHEMICAL FINDINGS FOR PREGNANT OR LACTATING FEMALES BY REGION, NIGERIA

	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Hemoglobin No.	29	-	26	18	37	14	124
gm/100ml Mean	284	-	298	176	386	149	1,293
			Percent Distribution				
<9.0 "Deficient"	13.8	-	-	22.2	2.7	-	7.3
9.0- 9.9"Low"	27.6	-	3.8	22.2	10.8	28.6	16.9
10.0-12.9"Acceptable"	58.6	-	88.5	50.0	83.8	57.1	71.0
≥13.0	-	-	7.7	5.6	2.7	14.3	4.8
Hematocrit No.	29	-	26	18	37	14	124
percent	33.9	-	38.7	33.2	33.9	35.6	35.0
			Percent Distribution				
<30 "Deficient"	13.8	-	-	22.2	8.1	7.1	9.7
30-34"Low"	41.4	-	11.5	38.9	43.2	35.7	34.7
35-37"Acceptable"	20.7	-	23.1	16.7	32.4	35.7	25.8
≥38 "High"	24.1	-	65.4	22.2	16.2	21.4	29.8
Mean Corpuscular No.	29	-	26	18	37	14	124
hemoglobin concentration Mean	30.3	-	31.0	31.2	32.5	31.5	31.4
			Percent Distribution				
<28.0	6.9	-	-	5.6	2.7	7.1	4.0
28.0-29.9	37.9	-	15.4	16.7	5.4	14.3	17.7
30.0-34.9	55.2	-	84.6	66.7	78.4	78.6	72.6
≥35.0	-	-	-	11.1	13.5	-	5.6
Plasma Vitamin C No.	29	-	25	14	37	14	119
mg/100 ml Mean	1.22	-	1.08	0.82	1.20	0.99	1.11
			Percent Distribution				
<.10 "Deficient"	-	-	4.0	-	-	-	0.8
.10- "Low"	3.4	-	4.0	-	-	-	1.7
.20-.39"Acceptable"	3.4	-	12.0	21.4	8.1	14.3	10.1
≥.40 "High"	93.1	-	80.0	78.6	91.9	85.7	87.4

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(Continued) APPENDIX TABLE 13. BIOCHEMICAL FINDINGS FOR PREGNANT OR LACTATING FEMALES BY REGION, NIGERIA

	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Plasma Vitamin A No.	29	-	21	16	37	13	116
µg/100 ml Mean	50.1	-	45.0	54.9	43.1	51.0	47.7
			Percent Distribution				
<10 "Deficient"	-	-	-	-	5.4	-	1.7
10-19 "Low"	3.4	-	-	-	5.4	-	2.6
20-49 "Acceptable"	41.4	-	57.1	31.2	45.9	38.5	44.0
≥50 "High"	55.2	-	42.9	68.8	43.2	61.5	51.7
Plasma Carotene No	29	-	21	16	33	13	116
µg/ 100 ml Mean	285	-	200	324	309	294	284
			Percent Distribution				
<30 "Deficient"	-	-	-	-	-	-	-
30- 79 "Low"	3.4	-	14.3	-	-	-	3.4
80-199 "Acceptable"	17.2	-	38.1	6.2	21.6	15.4	20.7
≥200 "High"	79.3	-	47.6	93.8	78.4	84.6	75.9
Plasma Cholesterol No.	28	-	26	17	38	14	123
mg/100 ml Mean	167	-	178	165	206	180	182
			Percent Distribution				
<50- 99	7.1	-	-	-	-	-	1.6
100-149	21.4	-	19.2	35.3	7.9	7.1	17.1
150-199	53.6	-	57.7	41.2	36.8	64.3	48.8
≥200	17.9	-	23.1	23.5	55.3	28.6	32.5
Iodine excretion No.	7	-	9	6	17	2	41
µg/gm Creatinine Median	80	-	219	84	94	202	108
			Percent Distribution				
<50 1/	-	-	-	-	-	50.0	2.4
50-99	57.1	-	11.1	83.3	52.9	-	46.3
≥100	42.9	-	88.9	16.7	47.1	50.0	51.2

1/ An excretion of iodine below 50 µg/gm creatinine is considered indicative of an inadequate iodine intake.

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(Continued) APPENDIX TABLE 13. BIOCHEMICAL FINDINGS FOR PREGNANT OR LACTATING FEMALES BY REGION, NIGERIA

	Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Thiamine Excretion No.	25	-	20	15	37	13	110
µg/gm Creatinine Median	130	-	138	71	121	61	103
			Percent Distribution				
<23 "Deficient"	-	-	5.0	13.3	2.7	7.7	4.5
23-54 "Low"	8.0	-	25.0	13.3	13.5	30.8	16.4
55-109 "Acceptable"	40.0	-	15.0	53.3	29.7	38.5	33.6
≥110 "High"	52.0	-	55.0	20.0	54.1	23.1	45.5
Riboflavin Excretion No.	27	-	23	15	37	13	115
µg/gm Creatinine Median	44	-	46	55	44	52	48
			Percent Distribution				
<39 "Deficient"	40.7	-	43.5	40.0	40.5	7.7	37.4
39-119 "Low"	55.6	-	43.5	26.7	56.8	76.9	52.2
120-399 "Acceptable"	3.7	-	13.0	26.7	2.7	15.4	9.6
≥400 "High"	-	-	-	6.7	-	-	0.8
N'methylnicotinamide No.	27	-	23	15	35	11	111
mg/gm creatinine Median	4.5	-	3.5	2.6	2.6	5.4	3.4
			Percent Distribution				
<0.6 "Deficient"	-	-	-	-	2.9	-	0.9
0.6-1.9 "Low"	7.4	-	26.1	26.7	31.4	-	20.7
2.0-4.9 "Acceptable"	44.4	-	47.8	33.3	51.4	45.5	45.9
≥5.0 "High"	48.1	-	26.1	40.0	14.3	54.5	32.4

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APPENDIX TABLE 14. BIOCHEMICAL LEVELS OF NUTRIENTS BY REGION IN CHILDREN 0-4 YEARS, NIGERIA

Region		Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Total Protein	No.	23	7	10	12	22	11	85
gm/100 ml	Mean	6.55	6.70	7.22	7.09	6.74	6.92	6.81
				Percent Distribution				
<6.0	"Deficient"	4.3	28.6	-	-	13.6	9.1	8.2
6.0-6.4	"Low"	43.5	-	-	8.3	18.2	9.1	8.2
6.5-6.9	"Acceptable"	26.1	-	30.0	25.0	31.8	18.2	24.7
≥ 7.0	"High"	26.1	71.4	70.0	66.7	36.4	63.6	48.2
A/G Ratio	No.	23	7	10	12	22	11	85
	Mean	1.08	0.93	1.10	1.14	1.21	1.01	1.10
				Percent Distribution				
<0.5		4.3	14.3	-	-	-	-	2.4
0.5-0.9		43.5	57.1	40.0	25.0	22.7	63.6	38.8
1.0-1.4		39.1	14.3	50.0	50.0	59.1	27.3	43.5
1.5-1.9		8.7	14.3	10.0	25.0	13.6	9.1	12.9
≥2.0		4.3	-	-	-	4.5	-	2.4
Serum Albumin	No.	23	7	10	12	22	11	85
gm/100 ml	Mean	3.30	3.20	3.74	3.67	3.62	3.39	3.49
				Percent Distribution				
<2.8	"Deficient"	8.7	14.3	-	8.3	4.5	9.1	7.1
2.8-3.4	"Low"	52.2	28.6	20.0	16.7	36.4	45.5	36.5
3.5-4.2	"Acceptable"	39.1	57.1	80.0	75.0	50.0	45.5	54.1
≥4.3	"High"	-	-	-	-	9.1	-	2.4
Serum Globulin	No.	23	7	10	12	23	11	86
gm/100 ml	Mean	3.26	3.50	3.50	3.38	3.12	3.52	3.32
				Percent Distribution				
1.0-1.9	"Deficient"	4.3	-	-	-	-	-	1.2
2.0-2.9	"Low"	39.1	28.6	30.0	33.3	34.8	36.4	34.9
3.0-3.5	"Acceptable"	30.4	14.3	30.0	41.7	52.2	9.1	33.7
≥3.5	"High"	26.1	57.1	40.0	25.0	13.0	54.5	30.2

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APPENDIX TABLE 14. BIOCHEMICAL LEVELS OF NUTRIENTS BY REGION IN CHILDREN 0-4 YEARS, NIGERIA (continued)

Region		Derived Savannah	Savannah	Plateau	Urban Federal District	Rain Forest	Coastal	Total
Hemoglobin	No.	23	7	10	14	24	12	90
gm/100 ml	Mean	189	55	100	135	241	121	841
				Percent Distribution				
<10.0	"Deficient"	73.9	100.0	20.0	42.4	29.2	33.3	47.8
10.0-10.9	"Low"	21.7	-	50.0	42.9	33.3	41.7	32.2
11.0-11.9	"Acceptable"	-	-	30.0	7.1	29.2	8.3	13.3
≥12.0	"High"	4.3	-	-	7.1	8.3	18.2	6.7
Hematocrit	No.	23	4	10	14	24	12	87
Percent	Mean	31.2	29.2	36.0	32.4	33.9	34.0	33.0
				Percent Distribution				
<30.0	"Deficient"	43.5	25.0	10.0	14.3	8.3	19.5	
30.0-33.9	"Low"	26.1	75.0	-	50.0	29.2	25.0	29.9
34.0-36.9	"Acceptable"	21.7	-	20.0	14.3	50.0	50.0	31.0
≥37.0	"High"	8.7	-	70.0	21.4	12.5	16.7	19.5
Mean Corpuscular Hemoglobin Concentration	No.	23	4	10	14	24	12	87
Percent	Mean	27.9	31.4	29.2	31.4	30.7	31.1	30.0
				Percent Distribution				
<28.0	"Deficient"	43.5	25.0	-	-	8.3	8.3	16.1
28.0-29.9	"Low"	30.4	25.0	80.0	35.7	29.2	33.3	36.8
30.0-31.9	"Acceptable"	17.4	25.0	20.0	42.9	33.3	16.7	26.4
≥32.0	"High"	8.7	25.0	-	21.4	29.2	41.7	20.7
Serum Vitamin C	No.	23	7	10	11	24	10	85
gm/100 ml	Mean	2.48	1.59	2.44	2.22	1.80	1.32	2.04
				Percent Distribution				
<0.10	"Deficient"	-	-	-	-	-	-	-
0.10-0.19	"Low"	-	-	-	-	-	-	-
0.20-0.39	"Acceptable"	-	28.6	-	-	-	20.0	4.7
≥0.40	"High"	100.0	71.4	100.0	100.0	100.0	80.0	95.3

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APPENDIX TABLE 14. BIOCHEMICAL LEVELS OF NUTRIENTS BY REGION IN CHILDREN 0-4 YEARS, NIGERIA (continued)

Region	Derived Savannah	Savannah	Urban Federal Plateau	District	Forest	Coastal	Total
Serum Vitamin A No.	21	6	10	12	16	8	73
µg/100 ml Mean	32.6	21.3	28.5	33.0	31.4	34.8	31.2
			Percent Distribution				
<10 "Deficient"	4.8	-	-	-	-	-	1.4
10-19 "Low"	4.8	50.0	10.0	8.3	12.5	-	11.0
20-49 "Acceptable"	85.7	50.0	90.0	83.3	81.2	100.0	83.6
≥ 50 "High"	4.8	-	-	8.3	6.2	-	4.1
Serum Carotene No.	21	6	10	12	16	8	73
µg/100ml Mean	122	38	50	116	163	134	115
			Percent Distribution				
<20 "Deficient"	-	-	-	-	-	-	-
20-39 "Low"	4.8	50.0	30.0	16.7	-	-	12.3
40-99 "Acceptable"	33.3	50.0	70.0	41.7	31.2	12.5	38.4
≥100 "High"	61.9	-	-	41.7	68.8	87.5	49.3
Serum Cholesterol No.	23	7	10	12	21	11	84
mg/100ml Mean	133	139	152	161	135	134	141
			Percent Distribution				
70-99	21.7	85.7	-	-	9.5	36.4	13.1
100-149	56.5	14.3	50.0	50.0	61.9	27.3	54.8
150-199	17.4	14.3	40.0	33.3	28.6	27.3	26.2
≥200	4.3	-	10.0	16.7	-	9.1	6.0
Thiamine Excretion No.	19	5	5	9	16	6	60
µg/gm Median	232	1,520	375	451	1,236	412	645
Creatinine			Percent Distribution				
"Deficient"	25.0	-	-	16.7	4.0	-	6.1
" "Low"	-	-	20.0	-	-	16.7	4.1
"Acceptable"	50.0	33.3	80.0	50.0	12.0	16.7	28.6
"High"	25.0	66.7	-	33.3	84.0	66.7	61.2
Riboflavin Excretion No.	16	5	3	5	15	5	49
µg/gm Median	167	173	250	156	180	42	168
Creatinine			Percent Distribution				
"Deficient"	28.6	33.3	28.6	40.0	23.1	85.7	35.0
"Low"	42.9	33.3	42.9	20.0	61.5	14.3	43.3
"Acceptable"	14.3	-	28.6	10.0	7.7	-	10.0
"High"	14.3	33.3	-	30.0	7.7	-	11.7
N'-Methyl-Nicotinamide No.	18	5	3	5	14	4	49
mg/gm Median	26.6	11.3	38.8	3.8	6.2	5.2	6.4
Creatinine			Percent Distribution				
<0.5 "Deficient"	-	-	-	-	-	-	3.3
0.5-1.59 "Low"	-	-	-	20.0	-	-	5.0
1.6-4.29 "Acceptable"	-	-	28.6	30.0	18.5	37.5	21.7
≥4.3 "High"	100.0	100.0	71.4	50.0	70.4	62.5	70.0

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APPENDIX 15

Intelligence Testing Materials

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APPENDIX 15. RECORD FORM FOR THE PERFORMANCE TESTS OF INTELLECTUAL PROCESSES (for use with 3, 4, and 5 year old children)

Name _____ Sex: M F Code _____

Birthdate _____ CA: _____ Examiner _____

1. Block Building

1. Tower : R W
2. Chair : R W
3. Bridge : R W
4. Pyramid: R W
5. Cross : R W

Raw score _____
Points _____

2. Three-hole Form Board

Item 1: Trial #1 R W
Time ____ seconds

Trial #2 R W
Time ____seconds

Item 2: Trial #1 R W
Time ____ seconds

Trial #2 R W
Time ____seconds

Raw score _____
Points _____

3. Copy of Designs

1. Lines : R W
2. Circle : R W
3. Cross : R W
4. Square : R W
5. Triangle: R W
6. Diamond : R W

Raw score _____
Points _____

4. Alternation Learning

1. R W
2. R W
3. R W
4. R W
5. R W
6. R W
7. R W
8. R W
9. R W
10. R W

Raw score _____
Points _____

5. Block Design

1. R W
2. R W
3. R W
4. R W
5. R W

Raw Score_____
Points_____

6. Sequence Tapping

_____ _____ _____ _____ _____ _____

_____ _____ _____ _____ _____ _____

_____ _____ _____ _____ _____ _____

Raw score _____ Points _____

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INSTRUCTIONS FOR ADMINISTERING AND SCORING PERFORMANCE TESTS OF INTELLECTUAL PROCESSES
(for subjects 3, 4, and 5 years of age -- used in Elite/Village Study)

1. BLOCK BUILDING (modified Ontario School Ability Examination):

This test is terminated whenever the subject fails one item.

Item 1: The examiner builds a tower three cubes high. He places three other cubes before the subject, saying: "Do that"; "Make one like mine", etc. If the subject fails to respond, he builds a tower for him, and otherwise induces the subject to respond correctly. No restrictions on time or trials.

Item 2: The examiner builds a chair of three cubes. The subject keeps his three cubes. He is asked to copy the model. No second chance is given. (Allow 1½ minutes.)

Item 3: The examiner builds a bridge of three blocks (a pair of pillars, one block high, one-half inch apart, joined by a top block). Three blocks are given the subject to copy the model. (Allow 1½ minutes.)

Item 4: The examiner builds a pyramid of six blocks and asks the subject to copy the model using the six blocks he is given, three blocks at the base, two blocks in the middle and one block at the apex. (Allow 1½ minutes.)

Item 5: The examiner builds a cross of four blocks. The subject is given four blocks and asked to copy the model. (Allow 1½ minutes.)

The score is one point per item completed correctly in the allotted time. (Maximum score is 5 points.)

2. THREE-HOLE FORM BOARD (1937SB Year II, 1; and II-6,6):

Item 1: Present the board with the blocks in place and the circle to the examiner's left hand. Say: "Watch what I do". Remove the blocks, placing each before its appropriate recess on the side toward the subject. Then say: "Now put them back into the holes". (Allow one minute.) Then follow with a second trial of one minute.

Item 2: Only if the subject correctly replaces the blocks in either trial 1 or 2 of Item 1, proceed to item 2. With the board placed so the circle is to the examiner's left hand, remove the blocks from the board while the subject watches, as before. Place each block before its proper recess on the side toward the subject. Then rotate the board while the subject watches. Then say, "Put them all back where they belong". Allow one minute. Then follow with a second trial.

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The score is found by adding the time in seconds required to complete Trial #2 of Item #1, and Trial #2 of Item #2, taking the reciprocal x 100. Thus, if the two trials took 21 seconds, the score is 1/21 x 100 = 4.78.

3. COPY OF DESIGNS (modified Ontario School Abilities Examination):

Use two sheets of plain white paper, one for the examiner, and one for the subject. Two soft pencils or crayons are used, one for the examiner and one for the subject.

Item 1: The examiner draws a straight line about 2 inches long, and asks the subject to copy it.

Item 2: The examiner draws a circle of about 2 to 3 inches in diameter and asks the subject to copy it.

Item 3: The examiner draws a cross by making two 2-inch lines which dissect at a 90 degree angle, and then asks the subject to copy it.

Item 4: The examiner draws a 2-inch square, and asks the subject to copy the pattern on his sheet of paper.

Item 5: The examiner draws an equilateral triangle with approximately 2-inch sides and asks the subject to copy it.

Item 6: The examiner draws a diamond with the top and bottom angles about 30 degrees (not square or bite-shaped), and asks the subject to copy it.

The score is one point for each item done reasonably well and one-half point for the emerging performance. Thus the maximum score is six.

4. ALTERNATION LEARNING:

Use one green and one blue plastic cup plus a red cube. Hide the cube under the blue cup to the right of the examiner. Then ask the subject to find it. Then place a shield between the examiner and the subject, alternating the blue cup from side to side, always leaving the cube under the blue cup. Allow 10 trials. Terminate when the subject correctly responds four times consecutively.

The score is the number of correct performances (one point per trial), counting trials to 10 above the last trial administered as correct. (Therefore, the maximum score is 10 with no errors.)

5. BLOCK DESIGNS (modified Koh's Block Test):

The examiner takes four and gives the subject four of the colored pattern blocks. The test is terminated after one incorrect trial.

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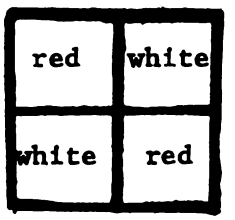
Practice trial: The examiner, using his own cubes, builds a square pattern with all four red faces uppermost. He then asks the subject to: "Make one like mine, all red." All encouragement and repetitions are permitted on the practice trial until the subject performs correctly. (Allow 2 minutes.)

Trial 1: The examiner overturns both sets of blocks gently. Then, using his own blocks he builds a square pattern with all four white faces upwards. He then asks the subject to make one like his. (Allow 2 minutes.)

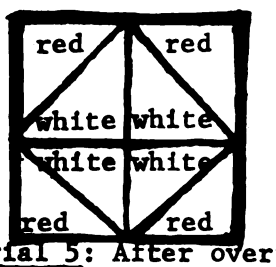
Trial 2: The examiner overturns both sets of blocks again. Then using his blocks, he builds a four-block design with two white blocks on the left and two red ones on the right. He then asks the subject to make one like this. (Allow 2 minutes.)

Trial 3: After overturning both sets of blocks again, the examiner



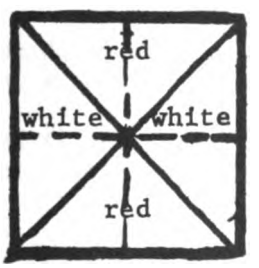
builds a four-block pattern, alternating red and white blocks. He then asks the subject to make one just like his. (Allow 2 minutes.)

Trial 4: After overturning both sets of blocks, the examiner builds



a four-block pattern as shown. He then asks the subject to make one just like his. (Allow 2 minutes.)

Trial 5: After overturning both sets of blocks again, the examiner



builds a four-block pattern, as shown. He then asks the subject to make one just like his. (Allow 2 minutes.)

The score is one point for each trial successfully completed.

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6. SEQUENCE TAPPING:

Use the Knox Cube Frame. Allowing 2 minutes, record the number of times the subjects can tap the 4 cubes in sequence with the eraser-end of a pencil, returning after each series of taps to the block on his right, and tapping from right to left. The score is the number of series tapped divided by 5.

Notes

Test #1: The Block Building items worked quite well. It may be desirable to time the items for a more refined score. Before beginning the test proper, in order to establish a good rapport, have the examiner and the subject work together in building as high a tower as they can, repeating until the subject is relaxed.

Test #2: The Three-Hole Form Board worked well. Again the trials may be timed for more refined scoring.

Test #3: The Copy of Designs test proved quite difficult for the village children who had not used paper and pencil. Therefore, it appears to have a heavy cultural bias.

Test #4: The Alternation Learning task did not seem to discriminate. This test needs to be refined and revised before being re-used.

Test #5: The Block Design test proved quite difficult. Additional easy items are needed.

Test #6: The Sequence Tapping test was fairly useful, but did not appear to measure higher mental processes. Instead it appeared to measure persistence, as was anticipated. This item may yet prove effective in malnutrition cases.

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APPENDIX 15 (continued)

RECORD FORM FOR THE VERBAL TESTS OF INTELLECTUAL PROCESSES
(used in the Elite/Village Study -- 3, 4, and 5 year old children)

Name_____ Sex: M F Code_____

Birthdate_____ CA:_____ Examiner_____

1. Identification of parts of the body

1. Head (ori)	R	W	7. Shoulder (ejika)	R	W
2. Eyelid (ipenpeju)	R	W	8. Armpit (abiya)	R	W
3. Eyes (oju)	R	W	9. Elbow (igunpa)	R	W
4. Ears (eti)	R	W	10. Thumb (itanparako)	R	W
5. Tongue (ahon)	R	W	11. Knee (ojugun)	R	W
6. Chin (agbon)	R	W	12. Heel (gigise)	R	W

Raw Score_____ Points_____

2. Identification of pictures

1. Hen (adiye)	R	W	6. Cow (malu)	R	W
2. Duck (pepaye)	R	W	7. Crocodile (oni)	R	W
3. Fish (ori eja)	R	W	8. Elephant (erin)	R	W
4. Axe (ake)	R	W	9. Sword (Ida)	R	W
5. Butterfly (labalaba)	R	W	10. Bow and arrow (ofa)	R	W

Raw Score_____ Points_____

3. Information

1. What do we use to buy (any item)?: Kini afi nra onje?	R	W	6. What do we use to boil water?: Kini a fin mu omigbona?	R	W
2. What is your name?: Kini oruko re?	R	W	7. With what do you smell?: Kini o fi ngbourn?	R	W
3. How old are you? Omo odunomelo nie?	R	W	8. What does a dog say? Kini Aja nwi?	R	W
4. What is this (pencil)? Kini yi " ?	R	W	9. What does a cat say? Kini ologbo nwi?	R	W
5. What do we do with it? Kini a fi nse	R	W	10. What does a car say? Kini Oko-ile nwi?	R	W

Raw Score_____ Points_____

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4. Action Agent

1. What cries? R W
   Kilo nsunkuni?
2. What flies? R W
   Kilo nfo lafefe?
3. What grows in the ground? R W
   Kilo nhu nile?
4. What lives in a hole? R W
   Kilo ngbe inu iho?
   e.g. what runs?, what sleeps?
5. What burns? R W
   Kilo njoni?
6. What cuts? R W
   Kilo nge nkan?
7. What hunts? R W
   Kilo nporan igbe?
8. What travels on water? R W
   Kilo nrinloju omi?
9. What stings? R W
   Kilo ntani?
10. What spoils? R W
    Kilo nbaje?

Raw Score_____ Points_____

5. Similarities

1. In the night we may see the moon, in the day we may see----------? R W
   Ni ale aleri osupa, ni osan aleri----------?
2. Yams come from the soil just as fishes come from what? R W
   Isu nwa lati inu ile gegebi eja ti nwa lati inu kini?
3. Bananas are covered with skins just as snails are covered with what? R W
   Epo ni owa lehin ogede, kini o wa lehin igbin?
4. Mother is a woman, father is a what? R W
   Mamma je obirin, Baba je kini?
5. A bird flies; what does a goat do? R W
   Eyie nfo geg bi Ewure se nse kini?

Raw Score_____ Points_____

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APPENDIX 15 (continued)

INSTRUCTIONS FOR THE ADMINISTRATION OF THE VERBAL TESTS OF INTELLECTUAL PROCESSES (for use with 3, 4, and 5 year old children)

Designed by E. T. Abiola, Child Development Unit, Institute of Education
University of Ibadan, Nigeria

The usual testing precautions of a congenial testing situation and of keeping the child at ease must be observed.

The Verbal Test must be given in the mother-tongue of the child, except in such cases where English or another Nigerian language is the language best spoken by the child.

The test begins after offsetting the initial apprehensiveness of the child by playing with brightly colored cubes. To sustain the child's attention, he or she is encouraged to continue playing with the cubes during examination.

1. Identification of parts of the body

The examiner says to the child: "Touch your head." Similarly, the examiner asks the child to touch other parts of the body that are listed in the record sheet.

2. Identification of pictures

The examiner shows the child each of the pictures of listed objects (record sheet) and says to the child: "What is this?"

3. Information

Normally the examiner repeats the questions as contained in the record sheet. But if the child fails to respond to question No. 8, i.e., "What does a dog say?", the examiner demonstrates by saying: "A dog barks and by imitating the barking of a dog.

4. Action Agent

The examiner demonstrates by saying: "What runs? A dog runs, etc.; What sleeps? A child sleeps, a cat sleeps, etc." The child is expected to confirm this and the examiner then proceeds by asking the questions as given in the record sheet.

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5. Similarities

The examiner asks the questions as contained in the record sheet.

Notes

Test #1: This test is in favor of the remote village children who wear little or nothing, and are taught the parts of the body by their guardian. The test needs more difficult items. These should be added.

Test #2: This item worked well.

Test #3: This item worked well.

Test #4: This item needs much more top.

Test #5: This item needs a few more difficult items.

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APPENDIX 15 (continued)

RECORD FORM FOR THE PERFORMANCE OF INTELLECTUAL PROCESSES
(for subjects 6 to 13 years -- used in Epe study)

Name_____ Sex: M F Code _____

Birthdate_____ CA:_____Examiner_____

1. Seguin Form Board

Trial #1:_____seconds
Trial #2:_____seconds
Trial #3:_____seconds
Score:_____

2. Knox Cube Memory-for-Sequence

	Trial #1		Trial #2			Trial #1		Trial #2	
1.	R	W	R	W	7.	R	W	R	W
2.	R	W	R	W	8.	R	W	R	W
3.	R	W	R	W	9.	R	W	R	W
4.	R	W	R	W	10.	R	W	R	W
5.	R	W	R	W	11.	R	W	R	W
6.	R	W	R	W	12.	R	W	R	W

Score:_____

3. Alternation Learning

1.	R	W	6.	R	W
2.	R	W	7.	R	W
3.	R	W	8.	R	W
4.	R	W	9.	R	W
5.	R	W	10.	R	W

Score:_____

4. Learning Shift

1.	R	W	6.	R	W
2.	R	W	7.	R	W
3.	R	W	8.	R	W
4.	R	W	9.	R	W
5.	R	W	10.	R	W

Score:_____

4. Tapping in Sequence

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

Score:_____

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APPENDIX 15 (continued)

INSTRUCTIONS FOR ADMINISTERING AND SCORING THE
PERFORMANCE TESTS OF INTELLECTUAL PROCESSES
(for subjects 6 to 13 years -- used in the Epe study)

1. Seguin Form Board (from Revised Form II of the Grace Arthur Scale of Performance Tests):

The form board and blocks are presented to the subject as recommended by Arthur. Gestures and commands by the examiner or helper are used to indicate that the blocks are all to be put back in their places as quickly as possible. The test consists of three trials.

The score is the time in the reciprocal of the seconds for the fastest trial x 1000/6. For example, if the fastest time is 88 seconds, the score is 1/88 x 1000/6 = 2 points.

2. Knox Memory Blocks (from Revised Form II of the Grace Arthur Scale of Performance Tests):

Set out four blocks in a row 2 inches apart (or use a Knox Block frame). The examiner taps out the sequences (series) listed in the Grace Arthur with a pencil at the rate of one per second. The pencil is then handed to the subject to repeat the series from memory. A second trial is given on each series, if the first is incorrect. The test is discontinued when the subject fails 3 series in succession. The subject receives 2 points for repeating the series correctly on the first trial, and 1 point for repeating the series correctly on the second trial.

The score is the total points correct.

3. Alternation Learning:

Use one green and one blue plastic cup plus a red cube. Hide the cube under the blue cup to the right of the examiner. Then ask the subject to find it. Then place a shield between the examiner and the subject, alternating the block from side to side, always under the blue cup. Allow 10 trials. Terminate when the subject correctly responds four times consecutively.

The score is the number of correct performances (one point per trial), counting trials to 10 above the last trial administered as correct. (Therefore, the maximum score is 10 with no errors).

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4. Learning Shift:

Repeat Test #3 changing the rules of the game. Now use two blue cups, plus a red cube. Place a shield between the examiner and the subject. With the shield in place, put the cube under the cup to the right of the examiner. Then remove the shield and have the subject look for the cube, raising one cup at a time until he finds it. Using the shield, proceed through the trials, always leaving the cube under the right cup, after much shuffling about. Allow ten trials. Terminate after the subject responds correctly four consecutive times.

The score is the number of correct performances (one point per trial) counting trials to 10 above the last trial administered as correct. (Therefore, the maximum score is 10 with no errors).

5. Sequence Tapping:

Use the Knox Cube Frame. Allowing 2 minutes, record the number of times the subjects can tap with the eraser-end of a pencil the 4 cubes in sequence, returning after each series of taps to the block on his right, and tapping from right to left.

The score is the number of series tapped divided by 5.

Notes

Test #1: The Seguin Form Board test worked well, providing both easy and difficult items. It should be retained in its present form to measure speed of visual perception and hand-eye coordination.

Test #2: The Knox Memory Blocks test also worked well. It should be retained to measure memory for sequences.

Test #3: The simple Alternation Learning task was intended to measure problem solving of a unique task, but it was not very satisfactory. It did not appear to discriminate as well as the first two tests, perhaps being too easy. This test should probably be revised and refined before being re-used.

Test #4: The Learning Shift task was not satisfactory. It failed to discriminate and therefore should be dropped or revised.

Test #5: The Sequence Tapping was intended to measure persistence and hand-eye coordination. It was especially designed to differentiate between children with poor and good nutrition. This test was good, having both easy and difficult items, and should be retained to measure perseverance.

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APPENDIX 15 (continued)

INSTRUCTIONS FOR THE ADMINISTRATION OF THE VERBAL TESTS OF INTELLECTUAL PROCESSES (for subjects 6 to 13 years -- used in the Epe Study)

Designed by E. T. Abiola, Child Development Unit, Institute of Education University of Ibadan, Nigeria

Direction:

Read each question as stated and in the order given. Read clearly. Substitute local variations of words as indicated in the general directions above. Do not wait too long for the response; the maximum time allowed per question is thirty seconds. Quickly write down the child's responses in the space provided in the score sheet. Do not ask leading questions. Do not explain the words or questions.

Association:

1. What do you smell with?
   Ki lo fi ngborun?

2. The knee is to the leg as the elbow is the what?
   Bi orugun ti ri si ese beni igupa se ri si kini?

3. Bananas have skins just as snails have what?
   Bi ogede se ni epo beni igbin se ni kini?

4. Why do some animals have thick shells?
   Nitori kini awon eranko miran se ni ikarawun tio nipon?

5. In the evening we see a red sky because the ____ is going down.
   Ni irole ama nri oju sanma to pupa nitori nkankan nlo, kilo nlo?

6. A man needs legs; a fish needs what?
   Gege bi enia se ni ilo ese re beni eja se ni ilo kini?

7. A horse needs legs; a bird needs what?
   Gege bi Esin se ni ilo ese re beni Eye se ni ilo kini?

8. For getting fish we can thank the fisherman; for getting cutlasses we can thank _____.
   Adupe lowo pajapeja nitori eja ti won npa fun wa, tani ama dupe lowo re nitori ada ti won nfun wa.

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9. We say it is wet or it is dry, as we say there is rain or there is what?
Gege by ati nwipe ile tutu tabi ile gbe, beni a nwipe ojo wa tabi kini wa?

10. A penny is only part of money; a day is only part of what?
Gege bi kobo se je ara owo beni ojo kan se je ara kini?

Pairs:

Listen carefully. Fi eti sile daradara.

Direction:

Read the list of pairs of words slowly from No. 1 to 10. Then call the first member of each pair, asking the child to supply the other pair, thus: Dog and what? Aja ati kini?

Then read the list again, this time from No. 5 to No. 1 and from No. 10 to No. 6. The child is tested from 1 to 10 again and the list is presented a third time from Nos. 6 to 10 and 1 to 5. The child is tested a third time as before from No. 1 to No. 10. The child's responses are recorded in the space provided in the record sheet.

List:

1. Dog and Cat
Aja ati Ologbo

2. Wood and Stone
Igi ati Okuta

3. Moon and Child
Osupa ati Omo

4. Forest and Air
Igbo ati Afefe

5. Name and Independence
Oruko ati Ominira

6. Flower and Lizard
Ododo ati Alangba

7. Locust and Bicycle
Esu ati Keke

8. Person and Firefly
Enia ati Tihuntihun

9. Cushion and Alertness
Timtim ati Akinkanju

10. Reindeer and Pantry
Agbamurere ati Ode

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Similarities:

1. In what way is a cutlass like a knife?
   Ni onowo ni Ada ati Obe fi jo ara won?

2. In what way is the moon like the stars?
   Ni ono wo ni Osupa ati Irawo fi jo ara won?

3. In what way is an orange like a banana?
   Ni ono wo ni Oronbo ati Ogede wewe fi jo ara won?

4. Which is the odd one out -- Sam, John, Don, Boy, Stan?
   Ewo ni koba awon toku mu ninu awon oro wonyi, Ajayi, Ojo, Olu, Omode, Bello?

5. In what way is a boy like a girl?
   Ni ono wo ni Omokunrin ati Omobirin fi jo ara won?

6. In what way are the ankle and the wrist alike?
   Ni ono wo ni Orun-owo at Orun-Ese firi bakan no?

7. Which is the odd one out -- boy, person, woman, man, girl?
   Ewo ni koba awon toku mu nimu awon oro wonyi, omokunrin, enia, obirin, okunrin, omobirin?

8. Which is the odd one out -- crying boy, pretty boy, tall girl, fat boy, thin girl?
   Ewo ni Koba awon toku mu nimu awon oro wonyi, Omookunrin tonsunkun, Omokunrin to dara, Omobirin to tinrin?

9. Which is the odd one out -- wood, mat, basket, pot, statue?
   Ewo ni koba awon toku mu nimu awon oro wonyi, Igi, Eni, Apere, Ikoko, Ere?

10. Which is the odd one out -- earth, town, sky, soil, heaven?
    Ewo ni koba awon toku mu nimu awon oro wonyi? Aiye, Ilu, Sanmo, Ile, Orun?

Problem-Solving:

1. Jumoke who is a girl is very wise. Is Abimbola who is a girl therefore very wise?
   Jumoke toje omobirin ni ogbon lopolopo, Nje Abimbola tohun na ja omobirin nlati ni ogbon lopolopo?

   All boys are not girls and therefore are not very wise?
   Gbogbo Omokunrin ki ise omobirin, nitori no won ko ni Ogbo lopo?

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Problem-Solving (cont'd.)

2. A two year old child thought he broke his leg; he needs ho?
Omo odun meji ti osope chun fi ese re da nilati lo ri tani?
A child of six at school, thought he broke his leg, he needs who?
Omo odun mefa ti owa ni ile iwe, ro wipe ohun fi ese da, tani yio lo ri?

3. If in the forest, you see a huge mad dog coming your way, what would you do?
Nigbati owa ninu igbo, Ti oba ri aja nla ti oya were ti o nbo ni odo re, kini o se?

4. Six children want to share 30 eggs equally, how many will each receive?
Awon omo mefa fe pin ogbon eyin dede, eyin melo ni omo kokan yio gba?

5. Everybody you met, in the new village, so far, is a negro; the next person you are likely to meet will be: European Lebanese, negro, old man, young child?
Gbogbo awon enia ti o pade ni abule tuntun na ni oje enia dudu, Nje o le so pe enikeni ti o pade tele awon ti o ti pade le je eyinbo, kora, enia dudu, arugbo okunrin, odomode?

6. If I buy 4 yams for 1/-, how much do I pay for 3 yams?
Ti mo ba ra isu merin ni sile kan elo ni mo san fun isu meta?

7. Rains in Nigeria are usually accompanied by thunder. A Nigerian who arrived in England yesterday noticed that the rain fell there without thunder. Is he right to say that:

1. rains in England have no thunder
2. rains in England are different from rains in Nigeria
3. some rains are without thunder
4. only Nigerian rains have thunder
5. rains everywhere are the same

Opolopo Ojo ti onro ni ile wa ni ama ani Ara. Omo ilu wa ti ode ilu oyinbo ni ana ri pe ojo ti o ro ni be lana ko ni Ara. Nje o le so pe 1. ojo ti o nro ni ilu oyinbo ki ini Ara.
2. Ojo ti o nro ni ilu oyinbo o yato si ojo ti ile wa
3. awon ojo miran ki ini Ara
4. ojo ile wa nikan ni o n ni Ara
5. ko si iyato ninu ojo ti o nro nibikibi

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8. If the rain that fell in England also had thunder, can we then say that:

1. Most rains in England also have thunder.
2. Rains in England are like rains in Nigeria.
3. All rains have thunder.
4. Some English rains have thunder.
5. Rains everywhere are the same

Ti ojo ti o ro ni ilu oyinbo ba ni Ara, nje o le so wipe:

1. Opolopo ojo ti o nro ni ilu oyinbo ni o nni Ara.
2. Awon ojo ti o nro ni ilu oyinbo at ojo ile wa ri bakan na.
3. Gbogbo ojo ti o nro ni o nni Ara.
4. Awon ojo ti ilu oyinbo miran ma nni Ara.
5. Ko si iyato ninu ojo ti o nro nibikibi.

9. Mustafa bought 5 bowls of rice for 1/3; Bello bought 24 oranges for 1/-. Mustafa and Bello want to exchange some oranges for some rice. What is a fair exchange:

2 bowls of rice for 1 orange
1 bowl of rice for 2 oranges
1 bowl of rice for 4 oranges
1 bowl of rice for 5 oranges
1 bowl of rice for 6 oranges

Mustafa ra panu iresi marun ni sile kan ati toro, Bello ra oronbo merinlelogun no sile kan. Mustafa ati Bello fe paro di e ninu oronbo ati iresi ti won ni ewo nimu awon wonyi ni won o se ki won ma tu ara won je:

paro panu iresi meji fun oronbo kan
paro panu iresi kan fun oronbo meji
paro panu iresi kan fun oronbo merin
paro panu iresi kan fun oronbo marun
paro panu iresi kan fun oronbo mefa

10. If Bello has all the rice he wants and is buying oranges to sell again, what can Mustafa do to get some oranges?

1. Take some by force from Bello.
2. Beg Bello to give him some.
3. Buy some from Bello at 2 oranges for a penny.
4. Buy some from Bello at 4 oranges for threepence.
5. Follow Bello a few miles to the village where the oranges come from.

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Bi Bello ko ba fe iresi mo, ti oba si nfi oronbo sowo ni ki ni nimu awon wonyi ni Mustafa le se ki o fi le ri oronbo ti o nfe:

1. Yio fi agbara gba oronbo ni owo Bello ni.
2. Yio be Bello ki o fun ni oronbo die.
3. Yio ra oronbo maji ni kobo kan ni odo Bello.
4. Yio ra oronbo merin ni kobo meta odo Bello.
5. Yio tele Bello fun ibuse die lati lo si abule ti Bello ti nra oronbo re.

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APPENDIX TABLE 16. RECOMMENDED DAILY ALLOWANCE OF THE MOST IMPORTANT NUTRIENTS 1/

Nutrient	Recommended Daily Allowance: Child aged one year	Man or adolescent boy	Woman or adolescent girl	Pregnant or lactating woman	Notes
Calories	1,000	3,200	2,300	variable	Allow an additional 1,000 Calories daily for heavy labor. Perhaps less needed in hot climate.
Protein gm	35	65	60	80	A mixture of plant proteins should be used together with some animal protein.
Vitamin A IU	1,500	2,500	2,500	4,000	Amount will depend on whether mainly from vitamin A or carotene.
Thiamine mg	0.5	1	1	1.5	Amount needed depends on Calorie intake.
Riboflavin mg	1	1	1	2	
Niacin mg	6	12	12	20	
Vitamin C mg	15	25	25	30	
Vitamin D IU	400	-	-	400	Temperate climates only.
Calcium gm	0.5-1	0.5-1	0.5-1	1.5-2	
Iron mg	5	8 2/	10 2/	18	

1/ From Report of the Health Education Seminar, Ministry of Health, Northern Nigeria, and the Institute of Administration, Ahmadu Bello University, Zaria, April 1964.
2/ Slightly larger quantities than those given are needed in later adolescence.

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APPENDIX 17

Regional Growth Charts

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FIGURE 21. GROWTH OF NIGERIAN GIRLS, DERIVED SAVANNAH REGION

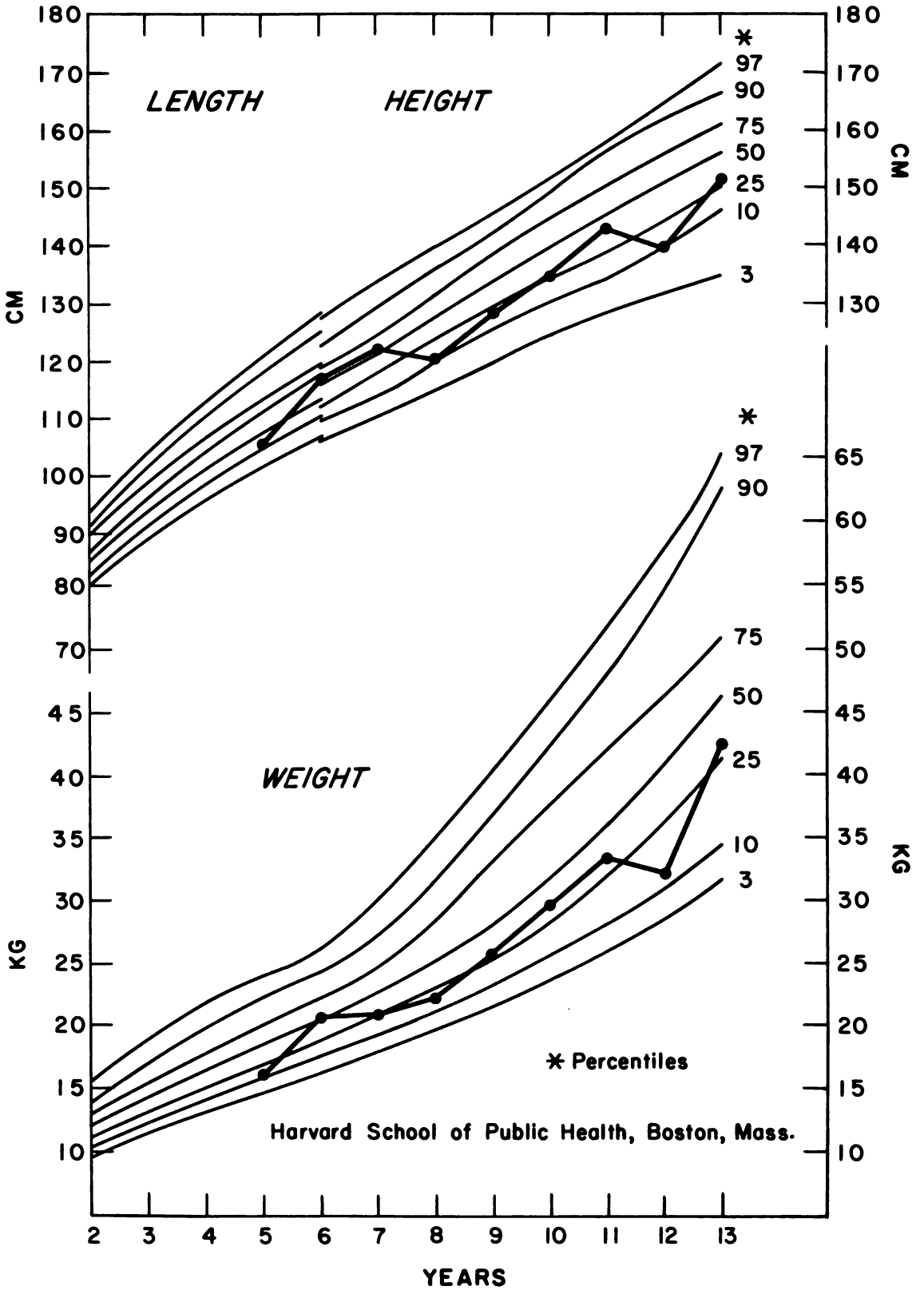

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FIGURE 22. GROWTH OF NIGERIAN GIRLS, SAVANNAH REGION

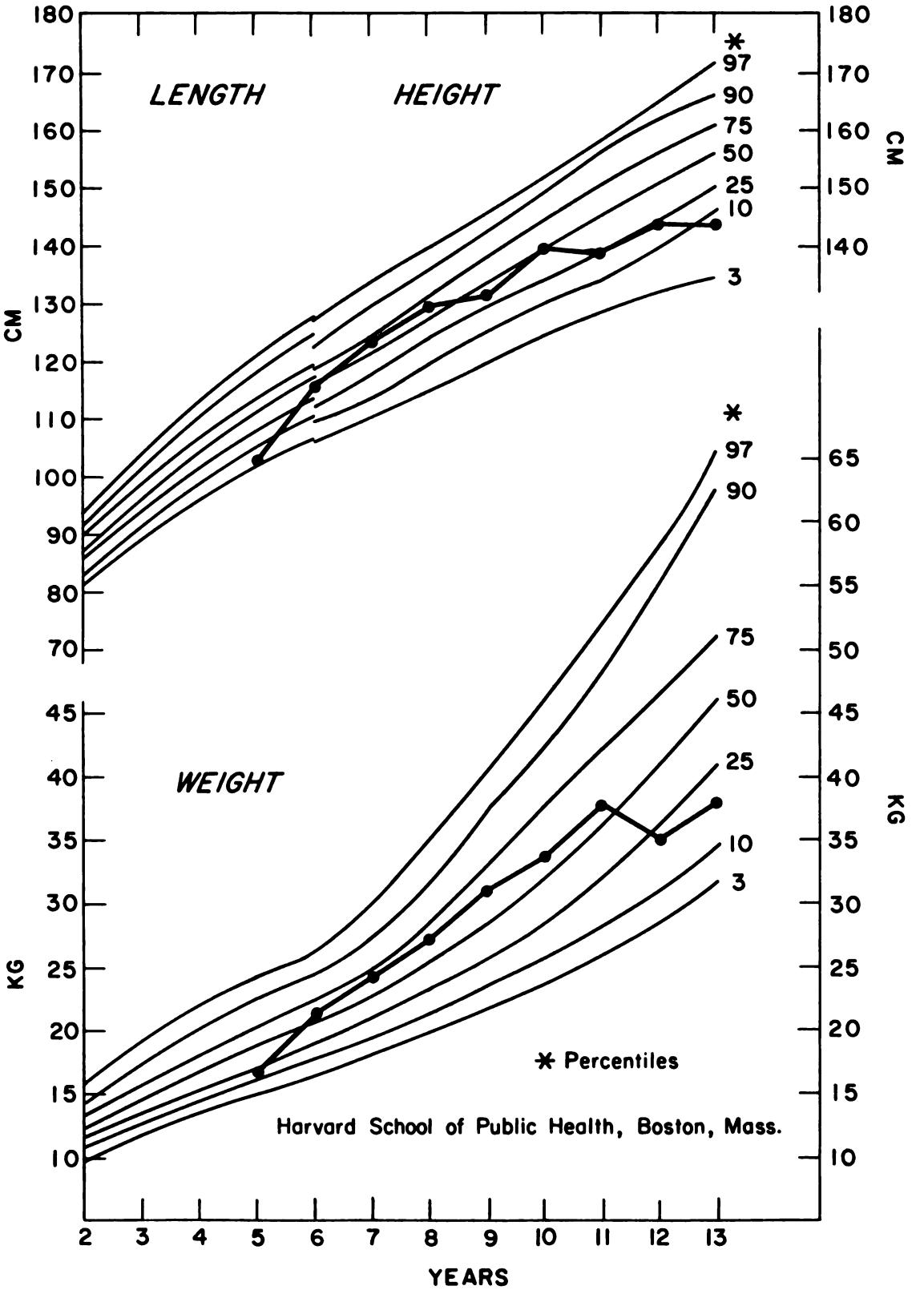

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FIGURE 23. GROWTH OF NIGERIAN GIRLS, PLATEAU REGION

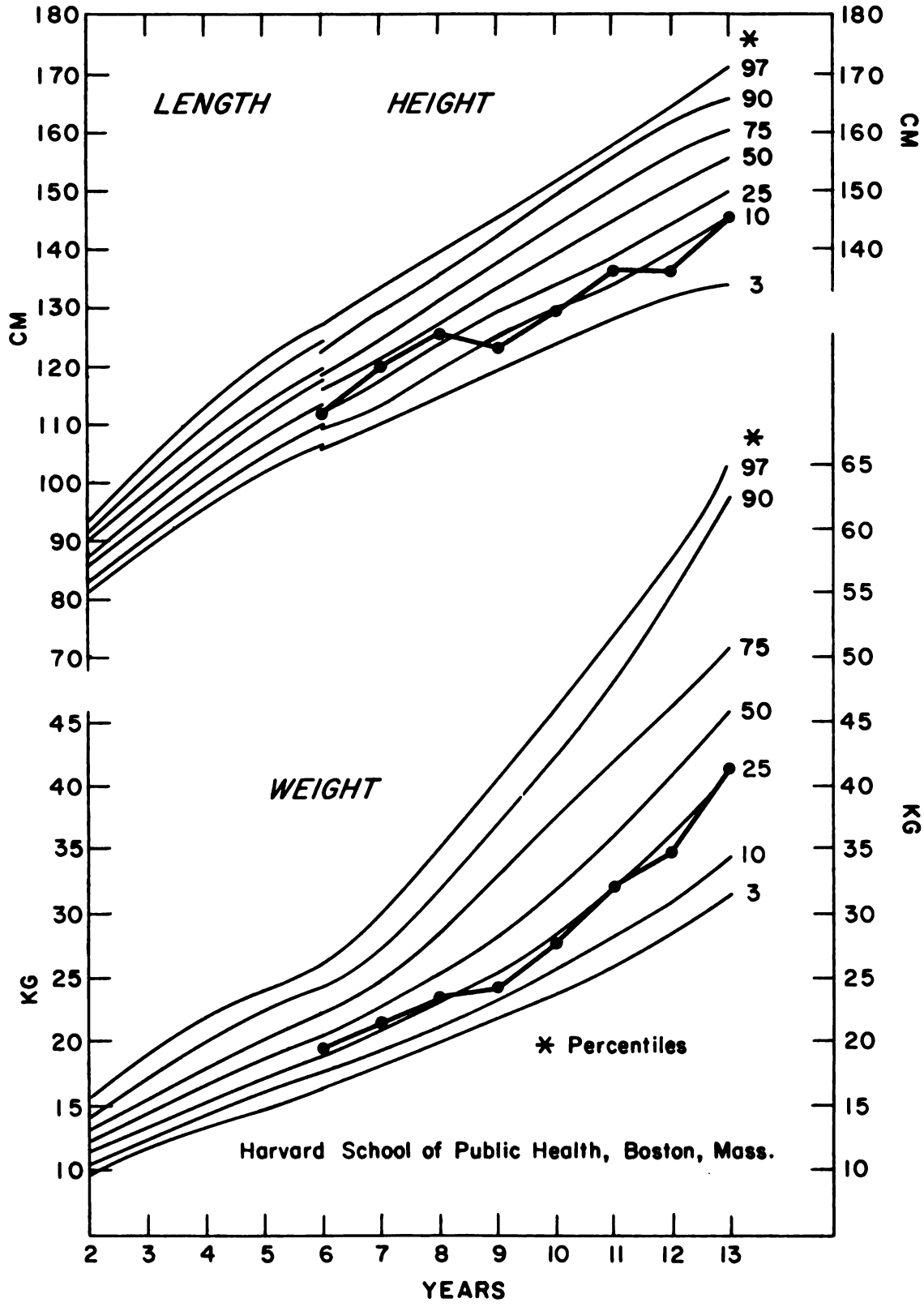

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FIGURE 24. GROWTH OF NIGERIAN GIRLS, URBAN FEDERAL DISTRICT

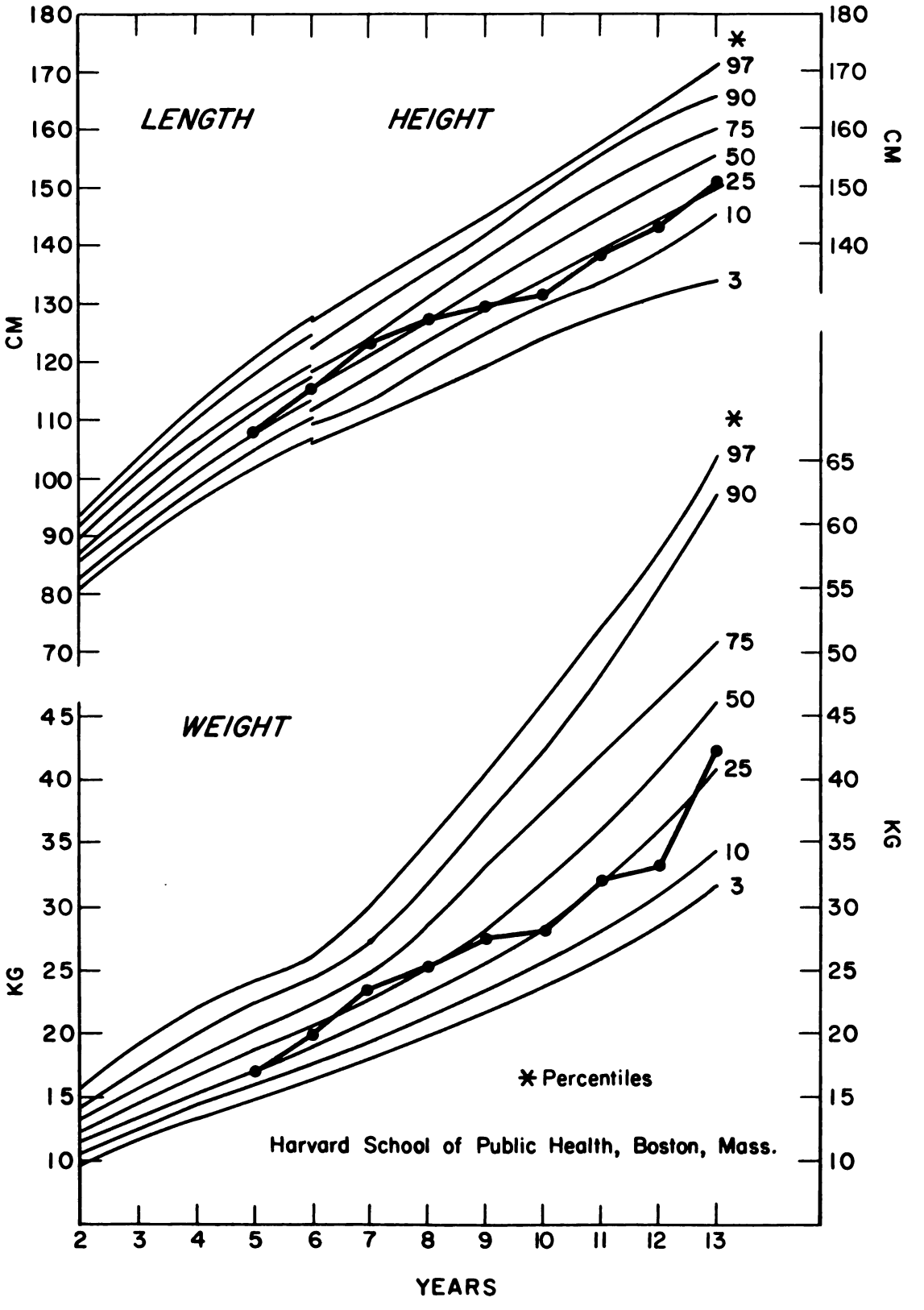

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FIGURE 25. GROWTH OF NIGERIAN GIRLS, RAIN FOREST REGION

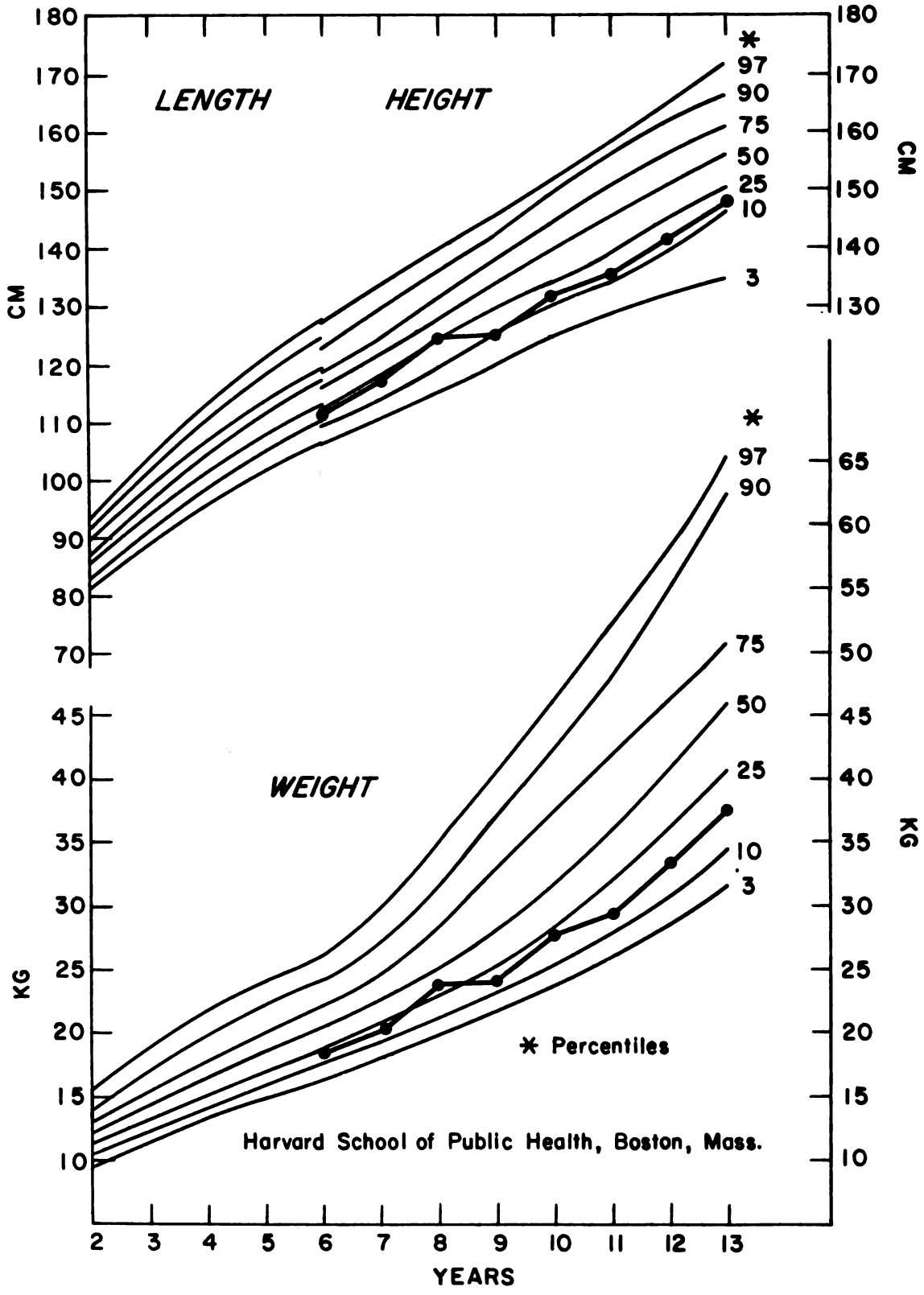

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FIGURE 26. GROWTH OF NIGERIAN GIRLS, COASTAL REGION

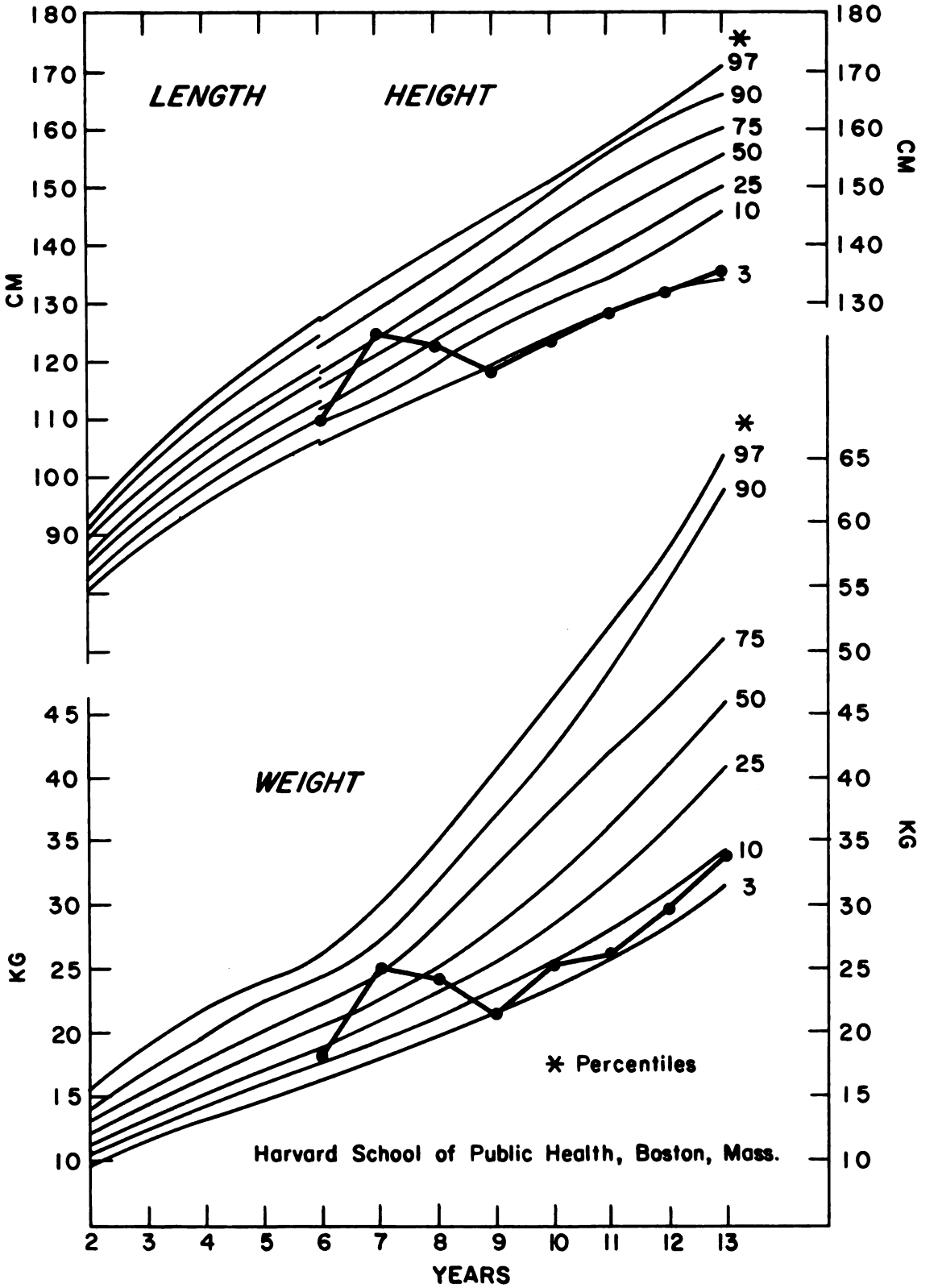

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FIGURE 27. GROWTH OF NIGERIAN BOYS, DERIVED SAVANNAH REGION

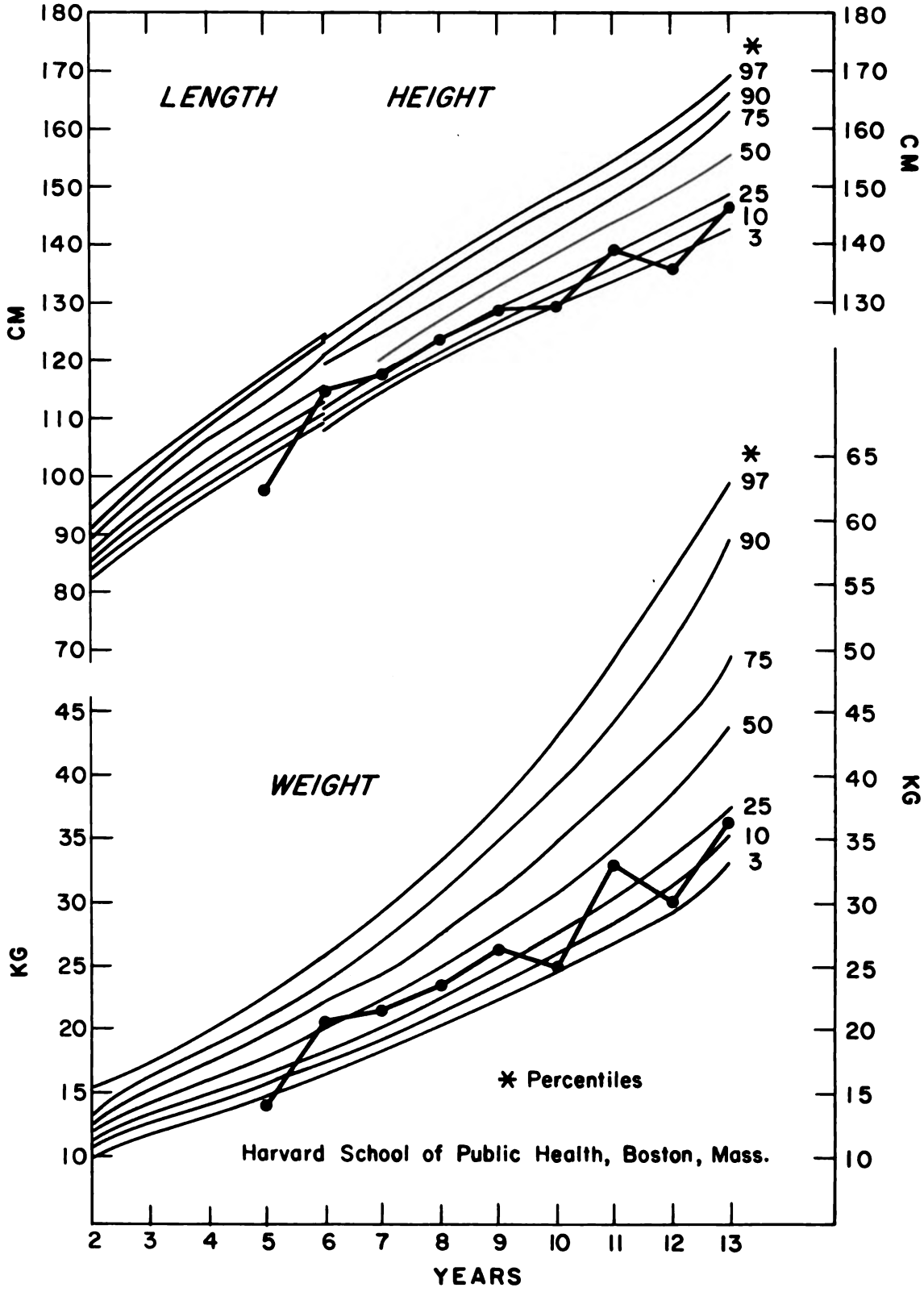

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FIGURE 28. GROWTH OF NIGERIAN BOYS, SAVANNAH REGION

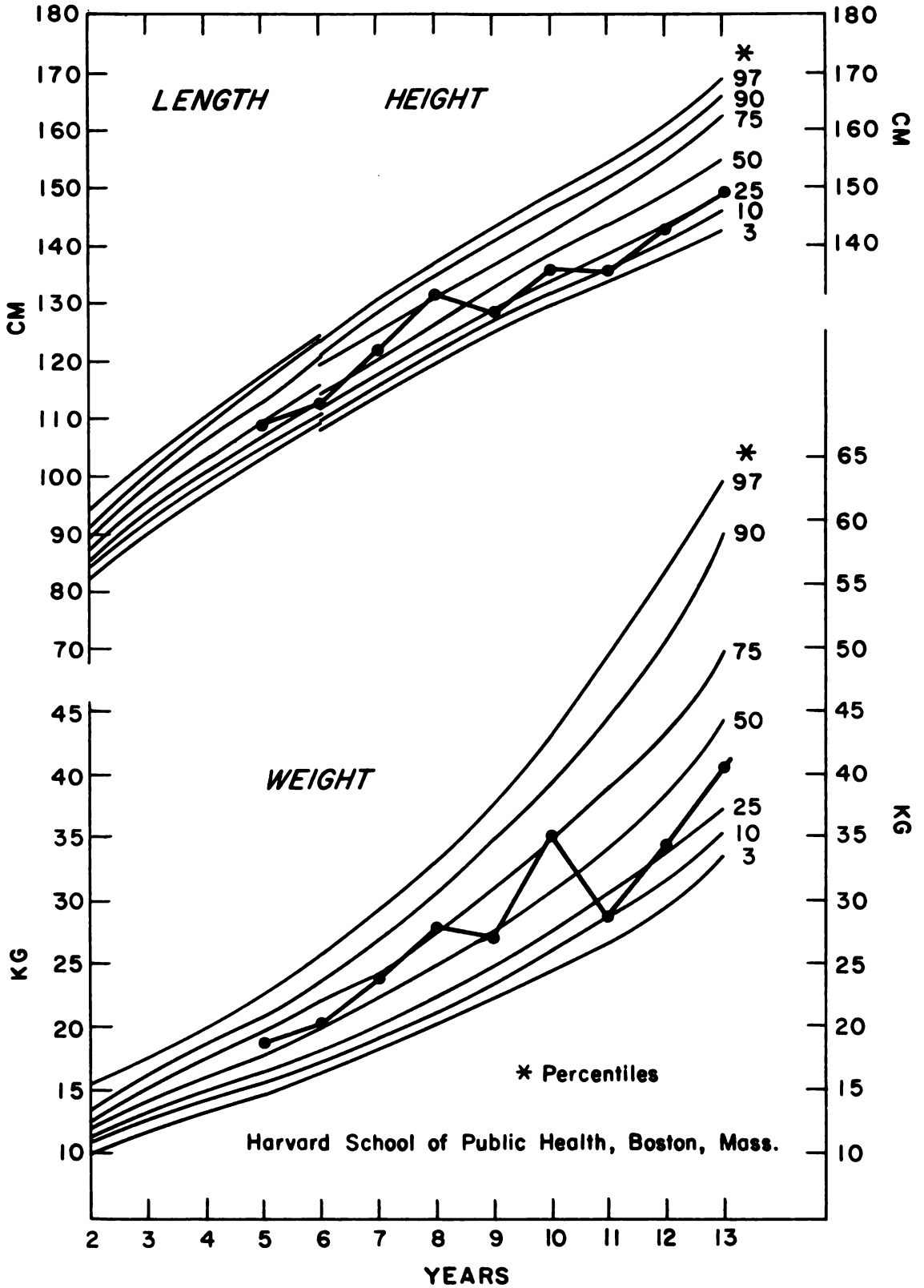

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FIGURE 29. GROWTH OF NIGERIAN BOYS, PLATEAU REGION

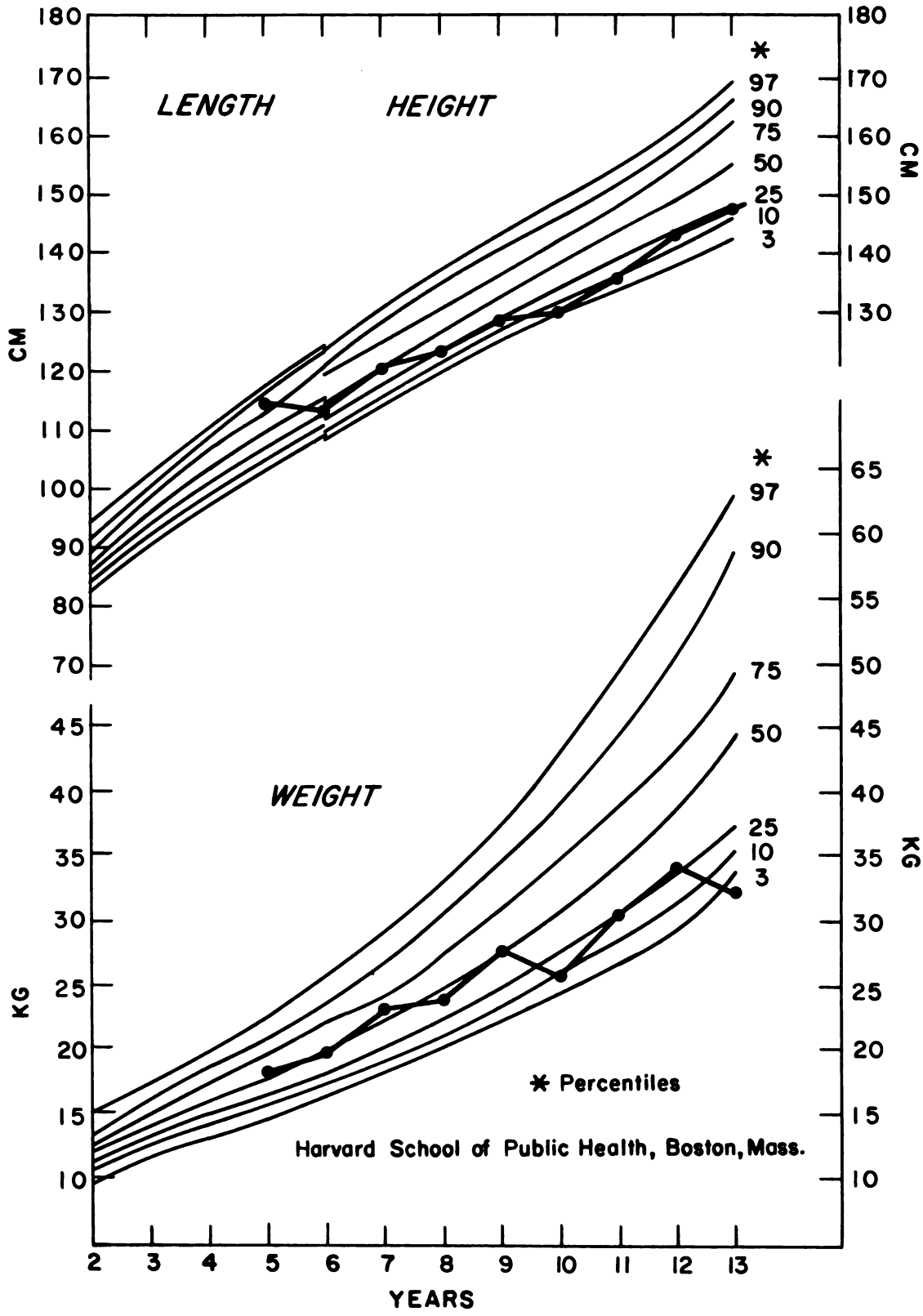

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FIGURE 30. GROWTH OF NIGERIAN BOYS, URBAN FEDERAL DISTRICT

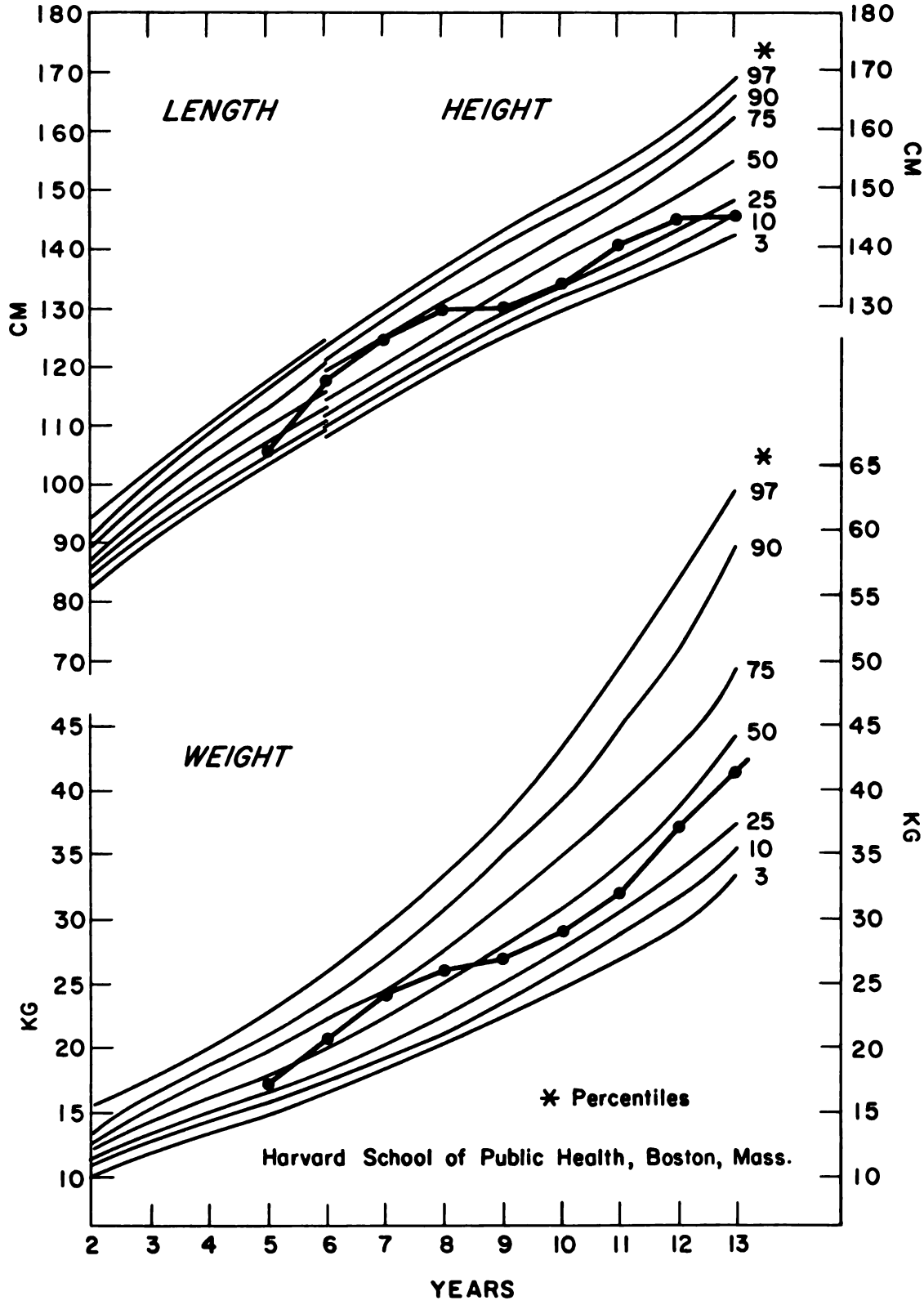

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FIGURE 31. GROWTH OF NIGERIAN BOYS, RAIN FOREST REGION

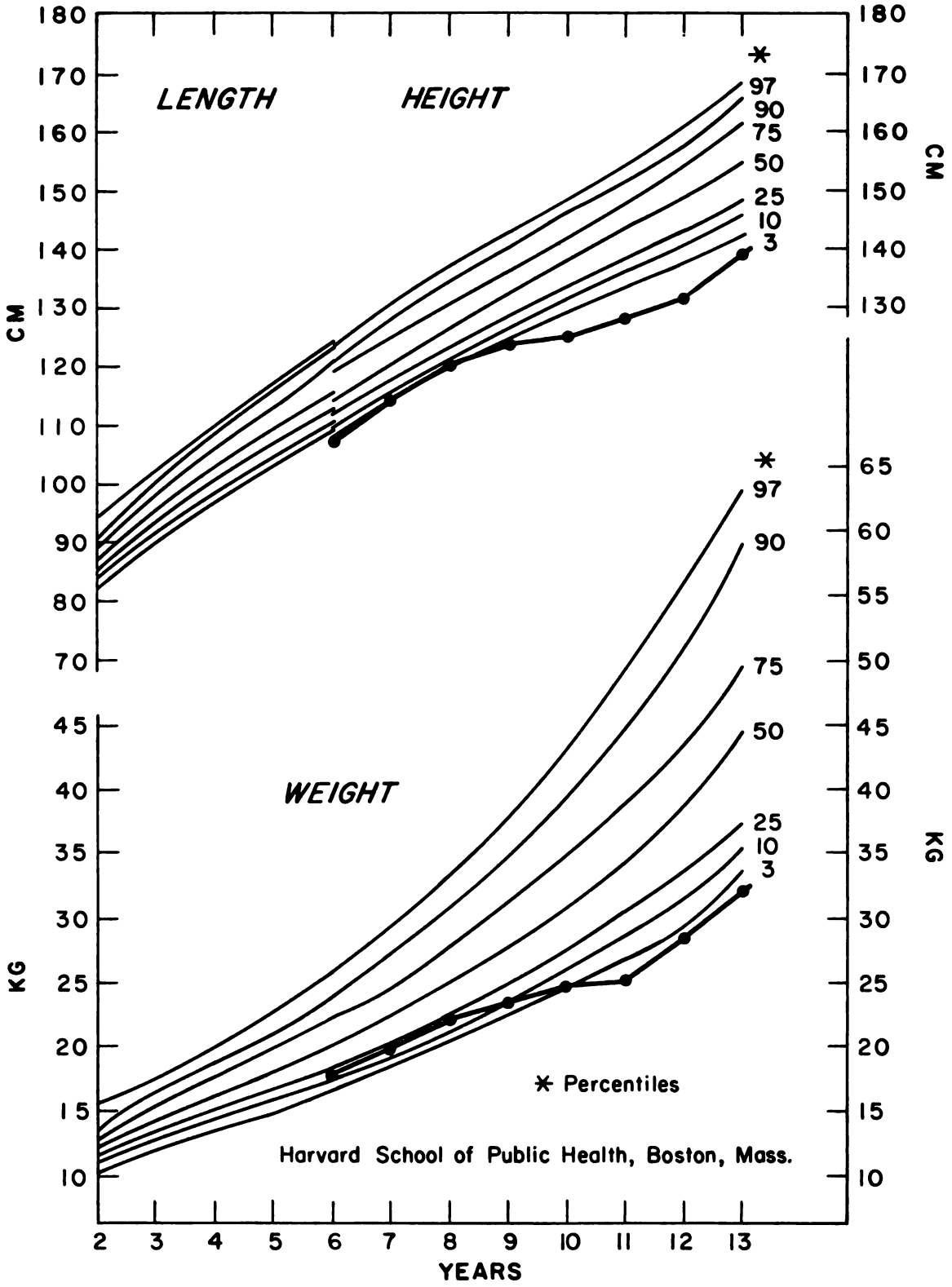

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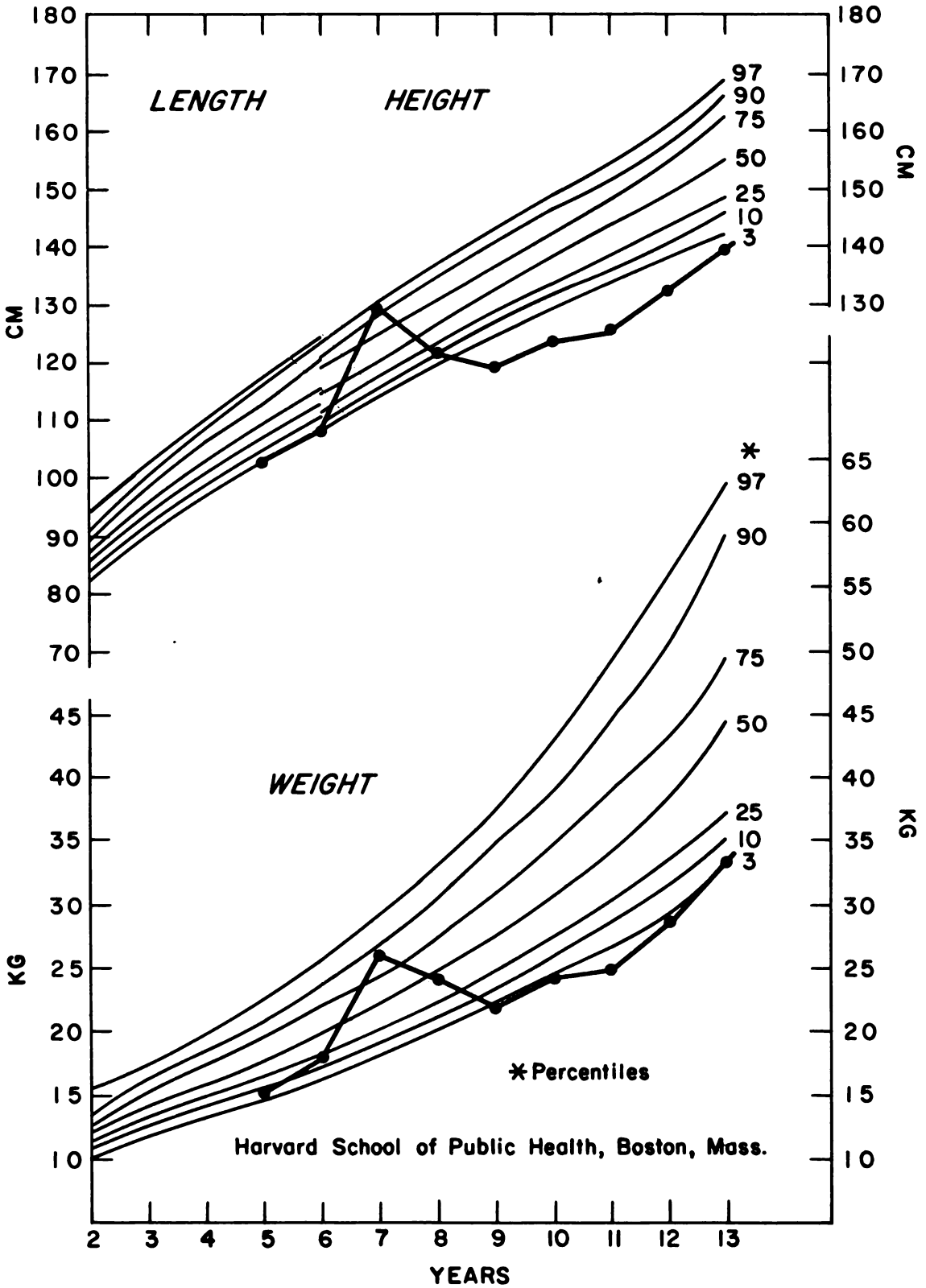
FIGURE 32. GROWTH OF NIGERIAN BOYS, COASTAL REGION



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